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Montana Tunnels Project Environmental Impact Statement

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Montana Department of State Lands

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Draft Environmental Impact Statement

Prepared by:

Montana Department of State Lands

Proposed Action:

Centennial Minerals, Inc., and U.S. Minerals Exploration Co. have filed joint venture plans with the Montana Department of State Lands to build and operate a new gold mine and mill known as the Montana Tunnels project. The project, planned for a 1,549-acre permit area west of Jefferson City, Montana, would last 12 to 13 years, including construction. The mine would produce 15,000 tons of ore per day, 7 days per week, for at least 10 years. The plant would produce gold and silver bullion, including lead and zinc concentrates. Employment for the project would peak at 551 jobs during construction; 340 jobs would be provided annually during peak operations.

More Information:

For additional information or copies of this EIS, please call or write:

Kit Walther
Department of State Lands
Capitol Station
Helena, MT 59620
or call (406) 444-2074

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Environmental Impact Statement

Draft

November 1985

MONTANA TUNNELS PROJECT

Montana Department of State Lands

Dennis Hemmer

Dennis Hemmer, Commissioner

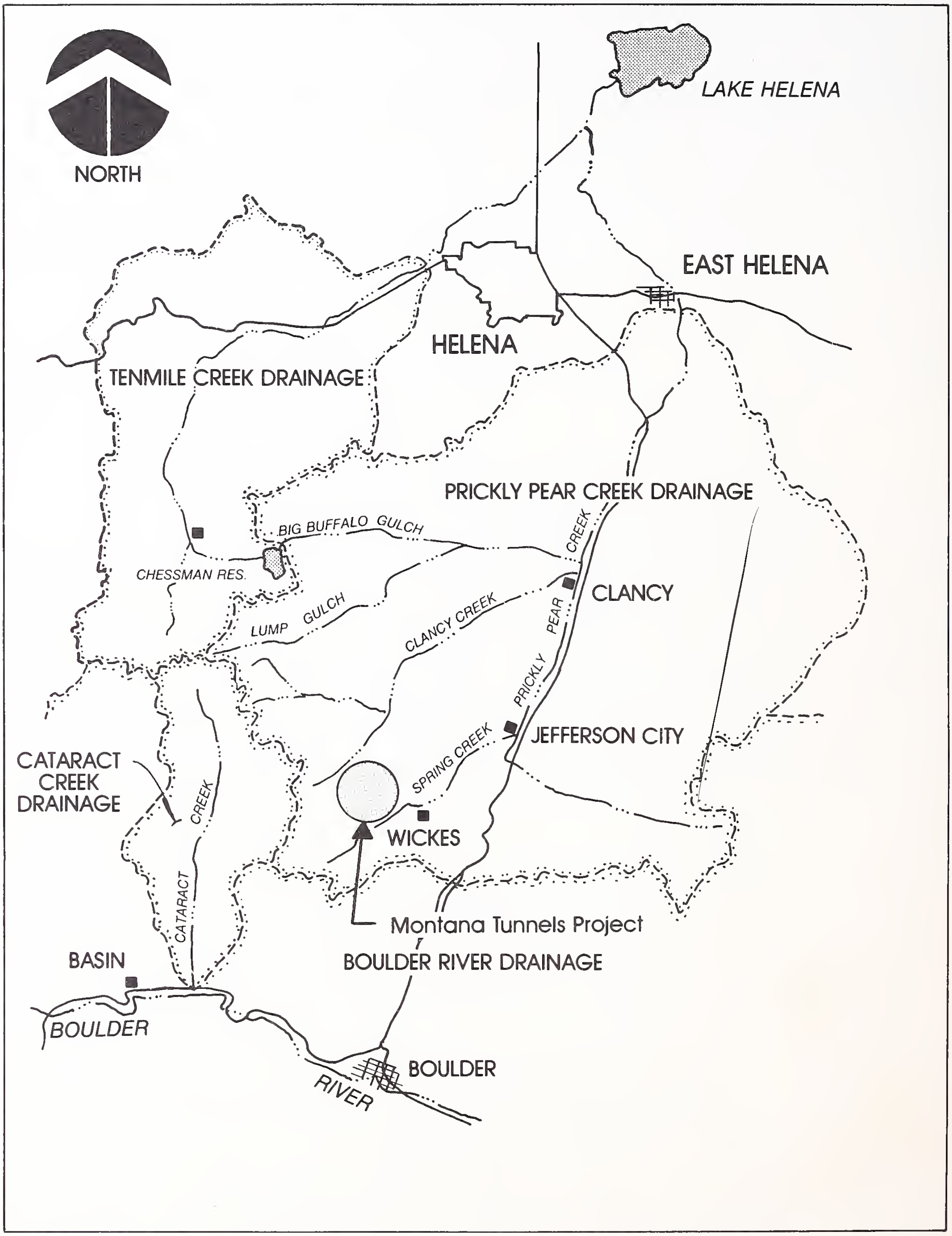

Figure S-1
The proposed Montana Tunnels project would operate near Jefferson City, Montana, south of Helena.

Summary

Centennial Minerals, Inc., and U.S. Minerals Exploration Co. have filed joint venture plans with the Montana Department of State Lands (DSL) to build and operate a gold mine and mill known as the Montana Tunnels project. DSL must decide whether to approve the permit as applied for, approve the permit with modified mining or reclamation plans, approve the permit subject to stipulations, or deny the permit.

AREAS OF CONTROVERSY

DSL held a public meeting on May 13, 1985, in Clancy, Montana, to air public concerns about the proposed Montana Tunnels project. DSL and the applicant presented an overview of the environmental impact statement (EIS) and public involvement processes. The concerns brought up at the meeting are detailed in Chapter I.

COMPARING ALTERNATIVES AND SELECTING THE PREFERRED ALTERNATIVE

The Choices

The environmental impact statement analyzes four alternatives, one of which is the applicant's proposal. The following discussion presents a summary of each alternative and DSL's preferred alternative.

Alternative 1 (The Proposal)

The applicant would construct and operate an open-pit, precious-metals mine according to the plan described in the application for a hard-rock mine operating permit. The project would last for 12 to 13 years. Construction and operation of the open-pit mine would disturb 965 acres of land, including 245 acres for the tailings impoundment and 421 acres for the waste rock dump. The mine would produce 15,000 tons of ore per day. The applicant would build an ore-processing plant that would produce gold and silver bullion and lead and zinc concentrates. At the end of mining, the applicant would remove all buildings and structures and reclaim land disturbed by the tailings impoundment, haul roads, waste rock dump, and plant site.

Alternative 2

The applicant's mining and reclamation plan would be the same as in alternative 1 (the proposal), except that a series of mitigating measures are assumed to be a part of the plan. The measures would help to: a) protect existing downstream water uses, b) protect aquatic life and fisheries in upper Spring Creek, c) reduce seepage from the water retention pond, d) prevent revegetation failure on the reclaimed tailings surface, e) prevent channel erosion next to the reclaimed waste rock dump, f) improve postmining wildlife habitat, g) insure forage supply for mule deer, h) reduce wildlife impacts, and i) reduce traffic hazards and inconveniences.

Alternative 3

The applicant's proposed production system arrangement--with an open pit, waste rock dump, tailings impoundment, water retention pond, and process plant--would combine elements of alternatives 1 (the proposal) and 2, but the ore processing plant would be located about 1/3 mile to the northeast of the proposed plant site, nearer to the permit boundary. Mitigating measures described in alternative 2 would be the same.

Alternative 4 (Denial of the Permit)

The applicant would not develop the Montana Tunnels project. The environmental, social, fiscal, and economic conditions (described in Chapter III) would not be affected by the applicant's project.

The Comparison

General effects of the alternatives, including the proposal, are listed in table S-1. Alternatives 1, 2, and 3 would have similar effects on the environmental and socioeconomic conditions; however, the mitigating measures for alternatives 2 and 3 would reduce a number of potential impacts of the proposal. Adverse impacts which cannot be mitigated or otherwise avoided by changing the production system arrangement (unavoidable impacts) include the following:

- --submergence of an open pit, creating a large lake containing poor-quality water,
- --disturbance of 932 acres of existing soils, vegetation, and wildlife habitat,
- --reduction of flows in Clancy Creek, lower Spring Creek, and Prickly Pear Creek,
- --removal of numerous intermittent springs,
- --reduced aesthetic qualities due to visual changes brought about by the pit, waste rock dump, and tailings impoundment, and the views of these disturbances from nearby areas,
- --increase potential for land use mismanagement due to a reclaimed landscape that is more susceptible to drought than the premining landscape,

--reduction in the usefulness of the postmine landscape,
--displacement of mule deer and elk,
--increased traffic.

As a result of denial of the permit, the landscape, vegetation, and soils would continue to provide uses similar to current uses. The historic mining character and agricultural and forest setting of the project area would predominate.

Denial would forego up to 551 quarterly job opportunities in construction and 340 annual jobs during mining that largely would benefit local residents because of the applicant's commitment to hire at least 80 percent of the work force locally. In addition, the area economy would not receive the benefits of increased personal income--amounting to $3.3 to $4.4 million during the first operational phase and $4.8 to $6.5 million during the second phase (an increase from 1 to 3 percent). Historic income and employment trends would continue--with income rising about 2 percent annually (real growth) and employment increasing about 1 percent annually. Also, the area would not be subject to the cyclical expansions and contractions of the mining industry. The annual project property tax revenues collected by Jefferson County and some of its political subdivisions, and project revenues paid to the state would not increase under this alternative.

The Preferred Alternative

Based on a comparison of the environmental, social, and economic advantages and disadvantages of each alternative, alternatives 2 and 3 are preferred.

SUMMARY OF IMPACTS BY DISCIPLINE

The following briefly describes the impacts that could occur if the Montana Tunnels project were permitted under applicable alternative scenarios.

Geology

Alternative 1

The combined flows of Homestake and Pen Yan creeks during flood events would be more than a small natural channel of an unnamed drainage could handle. Erosional downcutting and widening of the small, steep channel would occur during large runoff events.

Over time, slump failures, rock falls, and erosional processes within the open pit would slowly reshape the pit walls to a more stable slope angle. The post-reclamation landscape of the waste dump and tailings impoundment would not be subject to excessive erosion nor mass failures. However, the channel over the reclaimed impoundment would gradually downcut, resulting in a landscape slightly less stable than before mining.

Table S-1: Effects of Alternatives

Alternative 1	Alternative 2	Alternative 3	Alternative 4
--Moderately unstable postmining landform conditions.	--Slightly unstable postmining landform conditions.	--Slightly unstable postmining landform conditions.	--Stable landform.
--Temporary displacement of agricultural and recreational land uses.	--Temporary displacement of agricultural and recreational land uses.	--Temporary displacement of agricultural and recreational land uses.	--Agricultural and recreational land uses retained.
--Usefulness of the postmining landscape reduced.	--Minimized reduction in the usefulness of the postmining landscape.	--Minimized reduction in the usefulness of the postmining landscape.	--Usefulness of the landscape retained.
--Temporary displacement of mule deer and elk.	--Minimized temporary displacement of mule deer and elk.	--Minimized temporary displacement of mule deer and elk.	--Continued use of year-round ranges by mule deer and elk.
--Reduced acreages and quality of postmining wildlife habitats.	--Minimized reduction in the acreages and quality of postmining wildlife habitats.	--Minimized reduction in acreages and the quality of postmining wildlife habitats.	--Existing acreages and the quality of wildlife habitat retained.
--Temporary degradation of aquatic habitat in upper Spring Creek.	--Existing aquatic habitat conditions retained in upper Spring Creek.	--Existing aquatic habitat conditions retained in upper Spring Creek.	--Existing aquatic habitat conditions retained in upper Spring Creek.
--Temporary water availability conflict with Corbin water supply and downstream irrigators on Prickly Pear Creek.	--Existing water availability conditions retained.	--Existing water availability conditions retained.	--Existing water availability conditions retained.
--Destruction of six cultural historic sites.	--Destruction of six cultural historic sites.	--Destruction of six cultural historic sites.	--Historic sites retained; sites would continue to deteriorate due to weathering, vandalism, and relic collecting.
--Slight increase of air pollutant concentrations (TSP) above existing ambient levels.	--Increase of air pollutant concentrations would be minimized.	--Increase of air pollutant concentration would be minimized.	--Existing air quality levels would remain unchanged.

--Large open pit and sparse vegetation on reclaimed tailings impoundment visible from surrounding higher elevation areas. Agriculture and forest setting replaced by an industrial-urban setting.	--Large open pit visible from surrounding higher elevation areas. Agriculture and forest setting replaced by industrial-urban setting.	--Large open pit visible from surrounding higher elevation areas. Agriculture and forest setting replaced by industrial-urban setting.	--Views of historic mining properties, agriculture, and forest lands retained.
--Substantial traffic increases on Jefferson City--Wickes county road.	--Traffic volume reduced on Jefferson City--Wickes county road.	--Traffic volume reduced on Jefferson City--Wickes county road.	--Historic rates of traffic growth continue, between 1 to 3 percent annually.
--Small increase in population over baseline estimates.	--Small increase in population over baseline estimates.	--Small increase in population over baseline estimates.	--Stable 1 to 2 percent growth rate.
--Increased employment including 340 new full-time jobs at peak production and 168 to 224 secondary jobs.	--Increased employment including 340 new full-time jobs at peak production and 168 to 224 secondary jobs.	--Increase employment including 340 new full time jobs at peak production and 168 to 224 secondary jobs.	--Forgo 340 new full-time, mine-related jobs and ___ secondary jobs.
--Increased personal income (1 to 3 percent) from mine-related and secondary income contributions to the area economy.	--Increased personal income (1 to 3 percent) from mine-related and secondary income contributions to the area economy.	--Increased personal income (1 to 3 percent) from mine-related and secondary income contributions to the area economy.	--Forgo income contributions to the economy.
--Increased enrollment in Jefferson County and Lewis and Clark County schools.	--Increased enrollment in Jefferson County and Lewis and Clark County schools.	--Increased enrollment in Jefferson County and Lewis and Clark County schools.	--School enrollment would follow present trends.
--Higher tax and service revenues for some local government jurisdictions.	--Higher tax and service revenues for some local government jurisdictions.	--Higher tax and service revenues for some local government jurisdictions.	--No increased county or local government revenues.
--Increased revenues to state.	--Increased revenues to state.	--Increased revenues to state.	--No increased state revenues.

Alternative 2 or 3 (Preferred)

The impacts for alternative 2 or 3 would be the same as alternative 1 except that potential for channelization of waste rock diversion channels would be minimized.

Hydrology

Alternative 1

Excavation of the 162-acre, open pit would affect existing ground water flows; as many as 10 springs would be physically destroyed. Flow in springs within a one-mile radius of the open pit could be temporarily reduced. The pit would also induce ground water seepage from Clancy Creek. During the life of the mine, no more than 90 gallons per minute would seep into the pit from Clancy Creek. This flow would eventually decrease to about 10 gallons per minute. Water users downstream whose water rights pre-date the applicant's (senior appropriators) could be affected during low-flow periods.

After mining, the pit would continue filling with poor-quality water for about 480 years. Upon reaching equilibrium, water in the pit would be about 610 feet deep with a surface area of 103 acres. About 15 gallons per minute of poor-quality water would begin seeping into the ground water system.

Continuous pumping of the ground water production wells near Spring Creek could temporarily dewater a reach of this creek containing a population of small trout.

The depletion of flow in Spring Creek would diminish the flow of Prickly Pear Creek and potentially affect downstream senior appropriators during periods of low flow.

Seepage from the tailings disposal facility would occur through the base of the impoundment as well as through the process water retention pond. Seepage through the tailings impoundment would most likely end up as storage in unsaturated alluvium. Seepage through the process water retention pond is considered significant and may cause an increase in the concentration of heavy metals and total cyanide reaching Spring Creek. The concentration of arsenic, which already exceeds drinking water criteria, could also increase.

Drainage of poor quality water from the tailings impoundment into the process water retention pond could continue for at least five years after mine closure.

Alternative 2 or 3 (Preferred)

The impacts of these alternatives would be the same as alternative 1 except that seepage of poor-quality water from the process-water retention pond would be significantly reduced. Spring Creek would not become dewatered above Corbin.

Aquatics

Alternative 1

During mining, streamflow depletions could destroy macroinvertebrates and diatoms in Spring Creek or reduce their diversities. Reestablishment of aquatic communities in upper Spring Creek may be inhibited for 5 to 10 years after mining as contaminated seepage water from the retention pond reaches Spring Creek.

Streamflow depletions in upper Spring Creek could reduce abundance and diversities of aquatic communities in Prickly Pear Creek between Jefferson City and Clancy Creek.

Alternatives 2 or 3 (Preferred)

Streamflow depletions would not occur in upper Spring Creek. However, depletions of streamflow in lower Spring Creek could reduce abundance and diversities of aquatic communities in Prickly Pear Creek between Jefferson City and Clancy Creek.

Fisheries

Alternative 1

Dewatering Spring Creek could destroy or reduce a population of small trout. Those fish that escape the dewatering would be forced into inadequate habitat. Although Spring Creek flows would reestablish after mining, levels of cyanide may prevent repopulation by fish for 5 or 10 years. Reductions in the flow of Clancy and Prickly Pear creeks would not be great enough to affect fish.

Alternative 2 or 3 (Preferred)

Reductions in the flows of Clancy Creek and Prickly Pear Creek would not be great enough to affect fish. Trout habitat in Spring Creek would not be altered.

Soils

Alternative 1

Soils replaced at the surface of the tailings would probably become acidified and contaminated by trace elements over several decades, a process which would adversely affect plant growth. This, in turn, would result in progressively increasing erosion rates on the surface of the impoundment. In a worst-case scenario, most or all of the vegetation on the surface of the tailings could fail after several decades.

For all disturbed areas, postmining infiltration and percolation rates would be lower than premining rates, This change would result in higher runoff and erosion. The reclaimed lands would probably be more susceptible to mismanagement and drought than before disturbance. Natural soil development processes would eventually correct these impacts. Biological soil impacts would occur in most of the soils that are disturbed in the permit area. This could result in lower plant species diversity until soil microorganisms invade the reclaimed areas. Soil loss due to erosion off of the waste rock dump slopes, tailings dam, and cut-and-fill slopes would be low to moderate initially, and would decrease as vegetation becomes established. Postmining soil water- and nutrient-holding capacities would be low. This could lead to a less dense vegetative cover than existed before mining. Water- and nutrient-holding capacities would increase as the soil organic matter content increases naturally.

Alternative 2 or 3 (Preferred)

The impacts of this alternative would be the same as those described in Alternative 1 with the exception that soil acidification would be mitigated by capping the surface of the tailings impoundment with waste rock. Reclamation on the surface would be successful.

Vegetation

Alternative 1

Mining would destroy 932 acres of existing vegetation and 33 acres of previously disturbed lands. The postmining environment would contain significantly reduced acreages of grassland and forests. This decrease would correspond with a proposed increase in shrub/grassland acres, the creation of the open pit, and the potential failure of seeded grassland on the tailings site--this last due to acidification of soil. Lowered soil quality would limit the initial growth of seeded plants throughout revegetated areas; however, an erosion-controlling ground cover would develop over time. The vegetational composition of reclaimed lands would be dominated by relatively few species. Shrub densities would be far below premining densities and some shrub species would be eliminated. Reductions in tree densities, especially for Douglas-fir, would be noticeable. Several decades would be required for planted trees to reach premining heights. Over time, plant and woody species diversities would increase. Problems that could be encountered during revegetation include occasional erosion on steep slopes, introduction of weeds, and damage to developing plants by wildlife.

Alternative 2 or 3 (Preferred)

The impacts of this alternative would be the same as those described in alternative 1 except that the establishment of grassland on the tailings impoundment site would probably be successful. Also, the densities of conifers in reestablished forest would be comparable to premining density.

Wildlife

Alternative 1

Mining would destroy 932 acres of existing wildlife habitat. Mining activity and loss of summer range would force mule deer into surrounding habitats. Elk that use a winter-concentration area adjacent to the mine would move west to avoid mining activity. Mule deer and elk may eventually become accustomed to mining activity and begin using habitats near the permit area. Other wildlife species would undergo a similar displacement and habituation process.

Possible failure of 195 acres of reestablished grassland on the tailings impoundment site together with the excavation of a 162-acre open pit would significantly reduce wildlife habitat in the permit area. The quality of wildlife cover in reclaimed lands would be lowered due to reduced densities of shrubs and conifers. Mule deer, however, may benefit from the increased acreage of foraging habitat. Small increases in poaching, wildlife harassment, and road kills are anticipated.

Alternative 2 or 3 (Preferred)

The impacts of this alternative would be the some as those described in alternative 1 except that the grassland habitat on the tailings impoundment site probably would not fail. Also, the quality of coniferous cover would be comparable to premining cover quality.

Air Quality

Alternative 1

With the proposed emission control practices, the operation of the Montana Tunnels project would meet all Montana and Federal Ambient Air Quality Standards. There would be a slight increase in suspended particulate and trace-element levels in the ambient air, decreasing with distance from the project.

Alternative 2 or 3 (Preferred)

The emissions of fugitive dust on the access road would be reduced by a mitigating measure restricting traffic along this road.

Employment and Income

Alternatives 1, 2, or 3

The project would create 340 full-time jobs at peak operation. Total personal income in the study area due to direct project employment would total $4.8 to $6.5 million, adding 1.5 to 3.5 percent total employment in the study area. Secondary employment as a result of the project would create about 168 to 224 jobs and about $1.8 to $2.4 million annually in personal income in the study area. Total personal income would increase 1 to 3 percent above levels without the project.

Land Use

Alternative 1

The 1,549-acre permit area would be closed to all activities unrelated to mining for the life of the operation. As a result, between 282 and 401 animal unit months (AUMs) of grazing would be lost temporarily. The postmining landscape would contain reduced amounts of grassland and forest. Under a worst-case scenario, 7 acres of agricultural land in Jefferson County and between 10 and 17 acres of agricultural land in Lewis and Clark County would be converted to residential uses. Land-use conversions of this magnitude would be insignificant to agricultural production in Jefferson and Lewis and Clark counties.

As proposed, the mine and associated facilities would disturb a total of 965 acres--887 acres of native vegetation, 45 acres of cropland, and 33 acres of previously disturbed land. About 357 acres of the disturbance area (37 percent) would not be returned to its original land use. Because of this, about 40-60 AUMs of grazing would be lost permanently, and other agricultural uses would be precluded in this 357-acre area.

Alternative 2 or 3 (Preferred)

Impacts under alternative 2 would be the same as those listed under alternative 1 with the exception that the number of acres permanently lost would be reduced to the 162-acre open pit.

Sociology

Alternative 1, 2, or 3

Any adverse impacts on the sociology of the study area would be related directly to the number and distribution of workers moving into the area. Assuming the projected number and distribution of in-migrant workers presented in the demography section of this report, the only anticipated adverse impacts on the sociological environment would occur in community services (law enforcement and solid waste pickup) in rural Jefferson County.

In the unlikely event that a disproportionate number of workers should move to and reside in one area (for example, Eastgate near East Helena) adverse impacts could be expected in education and other community services.

Lewis and Clark County is not expected to suffer any adverse effects on the sociological environment. Government employment dominates the demography and social life of this county. In addition, the present availability of community services and housing is sufficient to handle project-related employees.

Recreation

Alternative 1, 2, or 3

The 1,549-acre permit area would be closed to the public for the life of the mine. However, the surrounding area offers diverse and abundant recreational opportunities, so this aspect of the project is insignificant.

Cultural Resources

Alternative 1, 2, or 3

Six historic sites would be destroyed by the project. Two of the historic sites, the Washington Mine and the Minah Mine, have been nominated for listing on the National Register of Historic Places. Three other historic sites would not be directly affected by the project. However, the sites could be affected indirectly by added vandalism or collecting due to increased activity in the area.

Aesthetics and Noise

Alternative 1

The project would be visible from parts of the Elkhorn Mountains to the east, as well as Mount Thompson and points along the Occidental Plateau to the southwest. Noise levels would increase over background levels due to project-related equipment and traffic.

Alternative 2 or 3 (Preferred)

The impacts under these alternatives would be the same as under alternative 1, except that decreased mine traffic would result in reduced noise levels.

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Chapter I: Selecting the Preferred Alternative

Centennial Minerals Inc., of Vancouver, British Columbia, Canada, and U.S. Minerals Exploration Co. of Denver, Colorado (referred to jointly as the applicant for the purposes of this EIS), propose to build and operate a gold mine and mill, known as the Montana Tunnels Project, in Jefferson County, Montana. The applicant must obtain a hard rock mining permit from the Montana Department of State Lands (DSL), in accordance with the Montana Metal Mine Reclamation Act.

THE EIS

DSL has determined that the proposed mining and reclamation plan may significantly affect the quality of the human environment. Therefore, the agency is required to prepare an environmental impact statement (EIS), according to the Montana Environmental Policy Act (MEPA), 1971. DSL must adhere to MEPA by following a detailed procedure that includes issuing this draft EIS, encouraging and accepting public comments on the draft, and issuing a final EIS if public comments require substantial corrections or clarifications of the draft EIS. DSL must make a decision on the application after complying with MEPA. DSL can make a decision no sooner than 15 days following compliance.

The EIS evaluates the effects that the Montana Tunnels project would have during operation, after the mine closes, and in combination with other activities that may affect the area. The EIS provides a forum for comment on DSL's analysis of the applicant's plan. The value of the EIS is that the public can look at a company's plan in detail and have a say in the evaluation of the plan. The preparation of the EIS helps assure that the proposed operation is well planned, that the environmental impacts of the proposed action are analyzed, and that the concerns of all agencies, organizations, and citizens are considered before a decision is made.

SCOPE OF THE ANALYSIS

DSL held a public meeting in Clancy, Montana, on May 13, 1985, to record the concerns of people interested in the Montana Tunnels project. An overview of the EIS and public involvement processes were presented. A comment period followed, so that people unable to attend the meeting could mail in their comments. From the meeting and letters received, DSL has compiled this list of concerns:

- --How would the project affect downstream water supply, demand, and quality, especially in Spring and Clancy creeks?
- --How would the chemical composition of the tailings and waste rock affect reclamation?
- --Would the pit slopes and tailings impoundments remain stable after shutdown?
- --Would the applicant salvage enough good-quality soil for reclamation?
- --What would be the effect of mine traffic--both cars and trucks?
- --Would the project affect aquatic organisms and fish?
- --Would the project affect elk and deer winter ranges?
- --Where would the mine work force live?
- --Would the project degrade air quality?
- --Would impact assistance be provided to Jefferson County by the applicant to offset capital and operating expenses of the county during the initial years of project start up? What forms of assistance would be provided?
- --Would water quality of Spring Creek and that of the Corbin water supply be affected by the applicant's project? What would be the effect of any water quality changes?
- --Are there procedural mechanisms available to local units of government to protect potentially affected communities from unanticipated economic impacts of the project if forecasted population and employment projections are in error?
- --How would wage rates and personal income of mine workers compare with the rest of the area as a whole?
- --Would reclamation begin only at the end of mining or would it be ongoing?
- --How many secondary jobs would be created from the primary employment of the applicant's project?
- --What effects might there be on government and other community services after closure of the mine? Would the county have problems responding to the effects of closure, either early or planned?

METHODS AND STUDY AREAS

In order to better understand the analyses for the several disciplines discussed in this EIS, a brief description of the study methods and areas of concern for each discipline follows.

Geology

Several published reports covering the regional geology, especially the Boulder Batholith/Boulder Mountain areas, were used to characterize the general geologic setting of the project area, (Blackwell and Robertson, 1973; Smedes, Klepper and Tilling, 1973). Additional information was obtained from other Montana-specific reports, such as the early silver boom-bust cycle of Montana (Chadwick, 1982) and the historical earthquakes of the Helena area (Qamar and Stickeny, 1983; and Stickeny and Bingler, 1981). Another report on the geology and mineral deposits of the Jefferson City quadrangle provided information about the area within and around the historic Corbin/Wickes mining district and proposed mine. The geology of the proposed permit area was also mapped and evaluated on a reconnaissance level by Sillitoe (1984) and recently updated by Centennial Minerals geologists (project application, 1984).

Hydrology

The surface water study includes analyses of water availability and water quality which primarily focus on Spring Creek and Clancy Creek. A discussion regarding existing water uses and water availability on Prickly Pear Creek is included in the EIS.

The ground water study evaluates the occurrence, movement, and quality of water in the Homestake and Spring Creek drainages.

Aquatics

Macroinvertebrates were collected in September and October, 1984, from 17 stations on Spring Creek and Clancy Creek and their tributaries. Samples were collected using a "unit effort traveling kick" method. Organisms were identified to the lowest practical taxon--usually genus--and enumerated. Diversities ($\bar{d}$), equitability (e) and relative abundance were calculated for each taxon and station.

Fisheries

Fish populations of Clancy Creek were sampled near its confluence with Kady Gulch and at the mouth of Quartz Creek (figure III-5). A segment of Spring Creek in section 11 was also sampled. Electroshocking was used to capture fish; mark-recapture methods were used to estimate population size.

Soils

A detailed soil survey was conducted on four sections (about 2,500 acres) in and around the proposed 1,548.7-acre permit area. Surveys of this nature determine the location and extent of the major soils in the area and serve as a guideline in predicting the availability, quantity, and quality of soil materials suitable for use in reclamation.

The survey was conducted according to standard procedures of the U.S. Department of Agriculture Soil Conservation Service (SCS), and current soil survey guidelines of DSL. The steepness and length of slopes, sources of parent materials, soil depth, coarse fragment content, vegetation cover, and chemical properties were major considerations in characterizing soil series and mapping units.

Soils were identified and mapped in the field on an enlarged aerial photograph scale where 1 inch equals 500 feet. Colored stereo aerial photographs (1:24,000) and an unpublished Helena National Forest soil survey for an adjacent area were used to identify and delineate soil mapping units.

Soil profiles were examined at existing road cuts or by excavating pits. The characteristics of each soil profile were described in detail by sequential horizons until bedrock, parent material unsuitable for salvage, or 60 inches in depth was reached. Soil units that differ markedly in physical or chemical properties from adjacent soils and which are about two acres or larger in size were delineated. Soil units that differed only slightly were not delineated unless they were five acres or larger in size. Soil series were designated arbitrarily using letters of the alphabet to avoid potential conflict with official SCS soil series names.

Each soil series was sampled. Soil samples were collected from each sequential horizon over three inches thick and were sent to the laboratory for analysis.

Vegetation

Except for some adjacent vegetation types, the vegetation study area was identical to the permit area. Vegetation was characterized by distributing transects throughout the study area. Canopy cover, plant frequency, and production were measured along the transects. Tree and shrub densities were also noted.

Wildlife

The proposed permit area is centered within the Montana Tunnels wildlife study area. The study area extends from Prickly Pear Creek west to the Occidental Plateau, north to Quartz Creek, and south to the headwaters of Spring Creek.

Observers traveled aerial, vehicle, and footpath routes and recorded sightings of animals. Data from pellet group counts, bird count transects, and small mammal traplines supplemented these recorded sightings.

Along with the study area, a cumulative impact analysis area was delineated. This area includes all additional range that could be visited by elk or mule deer that use the proposed permit area. The boundaries of the cumulative area were based on interviews with state and federal wildlife biologists (K. Constan and V. Yannone, Montana Department of Fish, Wildlife, and Parks; E. Wenzel, U.S. Department of the Interior, Bureau of Land Management; R. Juntunen, Montana Department of State Lands; C. Frounfelker, U.S. Department of Agriculture, Forest Service; all pers. comm., October 1985).

Air Quality

Total suspended particulate (TSP) baseline monitoring was performed using high-volume samplers. Sample filters were analyzed for a variety of trace elements using standard analytical techniques. The two monitoring locations were on the proposed permit area, but were considered representative of the general area beyond the permit boundary.

The EPA valley screening model was used to predict annual and short-term TSP concentrations resulting from the operation. Modeled receptor points were included to a distance of 5.25 miles from the plant site.

Employment

Cumulative impacts would occur if other projects were to develop concurrent with the Montana Tunnels project.

The cumulative impacts analysis assumes that Western Energy Company would develop the Chartam project near Winston, Montana, in Broadwater County. Depending on results of additional exploration activity, Western Energy could develop an open-pit gold mine in mid-1988 (Chuck Rose, Environmental and Special Projects Coordinator, pers. comm., October 8, 1985). The analysis also assumes that the Washington Corporation, which purchased the Anaconda property in Silver Bow County, could reopen the Berkeley Pit during the life of the Montana Tunnels project. Other exploration activities are not considered because development plans are unknown to DSL.

Sociology

The study area generally includes Jefferson and Lewis and Clark counties. However, demography and social life sections were focused on northern Jefferson County and southern Lewis and Clark County. The information used to analyze social science topics included personal interviews, the project application, and the hard-rock mine impact mitigation plan. Forecasts of population were derived from a survival-cohort model developed by Economic Consultants Northwest.

The project would affect the demographic environment of Jefferson County roughly corresponding to the Boulder Census Division and Lewis and Clark County corresponding to the Helena Census Division (see figure III-12).

Cultural Resources

A cultural resources inventory evaluation was conducted by GCM Services, Inc. to identify and record all heritage locations in the project area. Approximately 4 square miles were inventoried in Sections 8, 9, 16, 17, 20, and 21, T7N, R4W, except for the north portion of Section 9 and 3.2 acres in the NW¼NW¼ of Section 8 where access was denied.

All sites were mapped, recorded, and photographed and, when necessary, tested for subsurface cultural materials. Each site was assessed in terms of the 10 National Register criteria to determine potential eligibility for listing in the National Register for Historic Places.

AGENCY RESPONSIBILITIES

A number of agencies have or could have jurisdiction over the Montana Tunnels Project.

Montana Department of State Lands

DSL administers the 1971 Montana Metal Mine Reclamation Act (also called the Hard Rock Mining Act), with which the applicant must comply. The purposes of the act are, first, to recognize and protect the usefulness, productivity and scenic values of the lands and waters within the state, and second, to reclaim to beneficial use the lands used to metal mines. The act and its regulations (ARM 26.4.101 et seq.) set forth the steps that must be taken in the issuance of an operating permit for, and the reclamation of, the applicant's proposed mine and mill. The act applies to all lands within Montana.

State Historic Preservation Office

The State Historic Preservation Office has the responsibility to cooperate with and advise DSL when potentially valuable historical, archaeological, or other cultural resources are located in a project area (Montana Antiquities Act [MCA 22-3-401 through 22-3-442], and the National Historical Preservation Act [P.L. 89-665 as amended and reauthorized E.O. 11593]). Part of the advice given to DSL may include comments on an applicant's plan for impact mitigation of sites eligible for nomination to the National Register of Historic Places. The office also reviews the EIS to ensure compliance with cultural resource regulations.

The State Historic Preservation Office is responsible for issuing antiquities permits for projects on state lands. The office seeks determinations from the Keeper of the National Register for sites believed to be eligible for listing on the National Register of Historic Places. During mine operation, DSL is responsible for monitoring compliance with historic preservation and monitoring plans.

Montana Department of Health and Environmental Sciences (DHES)

Air Quality Bureau

The Air Quality Bureau of DHES administers the Montana Clean Air Act. Any proposed project that has the potential to emit more than 25 tons per year of any pollutant must obtain an air quality permit before beginning construction. The applicant must apply Best Available Control Technology (BACT) to each emission source. The applicant must also demonstrate that the project will not violate Montana or Federal Ambient Air Quality Standards.

Water Quality Bureau

The Water Quality Bureau of DHES is responsible for administration of the Montana Water Quality Act. This state law provides a framework for the classification of surface water. It also establishes surface water quality standards as well as permit programs to control the discharge of pollutants into state waters.

A Montana Pollutant Discharge Elimination System (MPDES) permit must be obtained before any discharge to surface water can occur. The MPDES permit contains water quality limitations and requires self-monitoring of effluent by the permittee. Mining operations must also comply with Montana ground water standards.

The tailings impoundment must be constructed and operated to prevent water discharge, seepage, drainage, infiltration, or flow that may pollute surface or ground waters. Complete plans and specifications for tailings ponds must be submitted to DHES no less than 180 days before initial construction.

Montana Department of Natural Resources and Conservation (DNRC)

DNRC administers two acts that are applicable to mining development in Montana. These are the Montana Major Facility Siting Act (MFSA) and the Montana Water Use Act. The MFSA requires state approval before construction of any electrical transmission line that exceeds 69 kilovolts (kV) or 10 miles in length. A water rights permit is required by the Montana Water Use Act for any surface water diversion or ground water withdrawal exceeding 100 gallons per minute.

U.S. Bureau of Land Management (BLM)

The Bureau of Land Management, Department of the Interior is the federal agency responsible for managing the mineral resources on public land administered by the BLM and other surface management agencies. The proposed mining permit includes some lands administered by the BLM.

The General Mining Law of 1872, as amended, gives authority for the location of mining claims on public lands. Activities on mining claims which cause surface disturbance are governed by the 43 CFR 3809 regulations.

The Bureau of Land Management's requirement for environmental review will be met by the environmental review conducted by the Montana Department of State Lands in compliance with the Montana Environmental Policy Act.

Hard-Rock Mining Impact Board

The Hard-Rock Mining Impact Board (board), created by the passage of House Bill 718 in 1981, is attached to the Montana Department of Commerce for administrative purposes. It is a quasi-judicial board intended to act as a "referee" in hearing disputes between local government units (for example, Jefferson County, the town of Boulder, and school districts) and large-scale mineral developers over the impact mitigation plan prepared by the developer. In the impact mitigation plan, the developer identifies the increased public sector costs associated with major mineral development and commits to pay, according to a specified time schedule, all increased capital and net operating cost to local government units that would result from development.

The review of the impact plan by the board is intended to occur concurrently with the procedure for fulfilling the operating permit requirements. If disagreement occurs between Jefferson County or any affected unit of local government and the applicant, the disagreeing party can file an objection with the board.

An operating permit issued by DSL for a large-scale mineral development will be conditioned to provide that mining may not begin until the board approves the impact plan. Furthermore, the permittee must provide a written guarantee of compliance to DSL and to the board. If the permittee does not comply with the commitment within the time scheduled, the State Board of Land Commissioners, upon receipt of written notice from the board, shall suspend the permit until it receives written notice from the board that the permittee is in compliance.

Hard-Rock Mining Impact Act

In 1981, the Montana legislature passed a law to allow local governments assistance in meeting the financial impact caused by large-scale mineral development. This law--the Hard-Rock Mining Impact Act--recognizes that such developments cause an influx of people many times larger than the number of mineral-development employees. The time lag between the cost of providing increased levels of government services and facilities and the increased tax revenue due to the development creates a burden for local taxpayers. In addition, the law recognizes that governments experiencing impacts may not have authority to tax the new development. In order to address such issues, the Hard-Rock Mining Impact Act was passed. The Act created a Hard-Rock Mining Impact Board (the board) and established a process for developers to identify and mitigate fiscal impacts to units of affected local governments.

Large-scale, hard-rock-mine developers must submit a hard-rock-mine impact mitigation plan to the board in order to receive a mine permit from DSL. Large-scale developments are those which employ an average of 75 people over any consecutive 6-month period. The impact plan must identify increased capital and net operating costs of local governments affected by the mine project and the developer's commitment to pay all such costs. Affected units of local government are those expected to increase services or facilities as a result of the construction or operation of a large-scale mineral development, or those that experience an adverse fiscal impact as the result of such development (MCA, 90-6-406 [1][a][b]).

The mitigation plan must present a timetable for project development, the estimated number of people moving into the area because of the project, the increased costs to affected units of local government, and the financial assistance (tax prepayments, low-interest loans, bond purchase) which the developer will provide to the local governments. Units of local government include counties, cities, towns, water districts, and sewer districts, fire districts, school districts, hospital districts, and refuse disposal districts.

If the impact plan identifies a jurisdictional revenue disparity between two units of government, that is, impacts occurring in a district that does not levy taxes on the mine or mill, then the taxable value of the development may be allocated among such jurisdictions. Allocations are based on the number of mineral employees residing within each jurisdiction. However, municipalities may receive no more than 20 percent of the taxable valuation (MCA, 90-6-404[1][a]).

A large-scale mineral developer must submit a draft impact mitigation plan to the affected units of local government and the board. During the 90-day review period, the affected government(s) may request financial or other assistance as necessary to evaluate the impact plan (MCA, 90-6-307[3]). Such financial assistance will be credited against future tax liabilities, if any.

During the 90-day review period, the developer and local governments may reach agreements about modifications to the draft plan. The description of modifications and proof of mutual agreement must be submitted to the board before the end of the 90-day review period if such changes are to be considered part of the final, approved document. If local governments have objections to the plan that cannot be resolved with the developer, the board will conduct a hearing in the county most affected by the project as determined by the board (MCA, 90-6-307[5]). The board will determine if action on the objection(s) is necessary and, if so, will amend the impact plan accordingly.

Once an impact plan is approved by the affected local governments and the developer, it may be amended according to provisions specified in the impact plan or providing one of three other statutory conditions is met. The plan can be amended if employment is forecast to increase or decrease by at least 75 workers over or below the employment levels specified in the approved impact plan. Within the first two years of commercial production, if it becomes apparent that the plan is materially inaccurate because of errors in the assessment, the plan may be amended. Finally, the governing board of an affected unit of local government and the developer may petition the board to amend the plan (MCA, 90-6-311[1][a][b][c]).

If the governing board of a local government not included in the impact plan believes that it should have been included, such board may petition the board to amend the impact plan. The board will decide if the local government is affected by the mineral development. If so, the developer will be required to mitigate increased capital and net increased operating costs for those affected local governments originally excluded.

The Hard-Rock Mine Impact Act also established the hard-rock-mining impact trust account, funded with 33-1/3 percent of the annual collections of the metalliferous mines license tax (MCA; 15-37-117). Grants and loans from the hard-rock-mining impact trust account are available to units of local government when a mining operation has permanently ceased operations or has reduced its full-time equivalent mining work force by 50 percent over the preceding 5-year period (90-6-321[1], MCA). The Hard-Rock Mining Impact Board may award grants and loans to pay for outstanding capital project expenses, to decrease unusually high property tax revenues, and to promote development of new industry or new employment opportunities in the area (90-6-321[2], MCA).

ADMINISTRATIVE ALTERNATIVES

After evaluating this EIS, DSL has a number of options. It may approve the permit as proposed, deny the permit, approve the permit with modified mining or reclamation plans, or approve the permit subject to stipulations.

Approve the Permit as Proposed

DSL could approve the project with no changes if it were to find the applicant's proposal environmentally acceptable.

Deny the Permit

DSL could deny the permit if the mining or reclamation plans were unacceptable under the laws administered by DSL or the water and air quality laws administered by the Department of Health and Environmental Sciences.

Approve the Permit with Modified Mining or Reclamation Plans

If the proposed plan were unacceptable, DSL could return it with a request that the applicant submit a modified plan. If, for example, DSL selected an alternative different from the applicant's proposal, DSL would require the applicant to submit new project plans.

Approve the Permit Subject to Stipulations

If parts of the proposal were considered unacceptable, DSL could grant the permit with stipulations. Possible stipulations would include any modifications or additions to the proposed plans that the Commissioner considered necessary to meet the requirements of state laws.

Chapter II:
The Montana Tunnels Project

THE ALTERNATIVES

Four alternatives to the applicant's proposal are covered in this EIS. Alternative 1 considers the applicant's project proposal as submitted in its application for a hard-rock mine operating permit. Alternative 2 considers the applicant's proposal, but mitigating measures that would reduce environmental impacts of the project are assumed to be a part of this plan. Alternative 3 considers the applicant's proposal and modifications of the mine plan. Finally, alternative 4 considers the no-action alternative, or permit denial. The consequences of each alternative are analyzed in Chapters IV and V. This chapter describes each alternative.

Alternative 1 (The Proposal)

In the applicant's proposal, mine construction would begin in 1986. Production would follow about 15 months later when construction of the ore-processing plant, tailings impoundment, associated service facilities, and open-pit development is completed. The mine would produce 15,000 tons per day of ore, 7 days per week, for at least 10 years. The ore-processing plant would concentrate and refine the ore into gold and silver bullion. In addition, the plant would produce lead and zinc concentrates. The applicant estimates total pit reserves at 52,500,000 tons, using 0.02 ounces per ton cutoff gold equivalent grade of the ore body. Waste-product tailings from the ore-processing plant would be deposited in a drained tailings disposal facility. Waste rock from the pit would be dumped near the pit and tailings disposal facility. The project would last about 12 to 13 years, including one year for mine development, 10 years for operations, and 1 to 2 years for reclamation. If gold prices are high enough, the mine operations could extend beyond 10 years.

Mining of additional ore reserves could extend the life of the mine. More waste rock would have to be disposed of, as would mill tailings. Sufficient area exists for disposal of waste rock. Additional tailings could be disposed of by raising the (rock fill) embankment. For example, 50 feet added to the embankment height would add another 5 years of storage capacity.

The permit area would encompass 1,549 acres in parts of Sections 8, 9, 16, and 17, T7N, R4W in Jefferson County. About 4 percent of the project area has been disturbed by previous mining. The project would disturb a total of 965 acres (see table II-1).

Table II-1: Surface Area Disturbance

Facilities	Acres
Tailings disposal facility	245
Waste rock dump	421
Open pit	162
Ore-processing complex	73
Topsoil stockpiles	53
Water retention pond	11
Total disturbed area	965

Source: Project application, 1984.

The surface within the proposed permit boundary, with the exception of about 135 acres of BLM ownership, is held by Centennial Minerals Inc. through purchase agreements, lease agreements, or options to purchase agreements (see figure II-1).

Mine Plan

The applicant would develop an open-pit mine that would produce 15,000 tons of ore per day, 350 days per year, or 5.25 million tons per year, at present metal prices. Excavation would produce 187.3 million tons of waste rock which would be hauled by 100-ton haul trucks to a dump site south of the pit. The pit would cut into a ridge on a moderately sloping hillside dividing Clancy Creek and Homestake Creek (an upper tributary of Spring Creek). Construction would include leveling the natural contours to bench elevations and developing access roads to various parts of the pit. Trees and topsoil would be removed from the early scheduled mining areas at the same time. Most topsoil would be stored for reclamation. Excavation of ore would begin before the process plant is ready. This ore would be stockpiled to provide a steady supply of ore once the plant becomes operational. Initially, four U-shaped benches would be opened by a small gully that cuts into the hillside at the center of the ore body. The pit access road would be constructed near the gully at an elevation of 5,710 feet. As mining progresses, ore would be excavated in 30-foot-high benches; the haul roads would follow a conventional spiral. Overall, the pit walls would slope 45 degrees.

The primary method of open-pit mining would entail drilling, blasting, loading, and hauling by truck to a crusher. The softer ore would be removed (ripped) with machinery and loaded into trucks. Blasting would be used to loosen the more competent ore and rock. Generally, blasting would occur once per week.

At the end of mining, the elevation of the pit bottom would be 4,960 feet. Depth of the pit at its center would be about 760 feet. The pit would measure 3,550 feet in length and 2,220 feet in width.

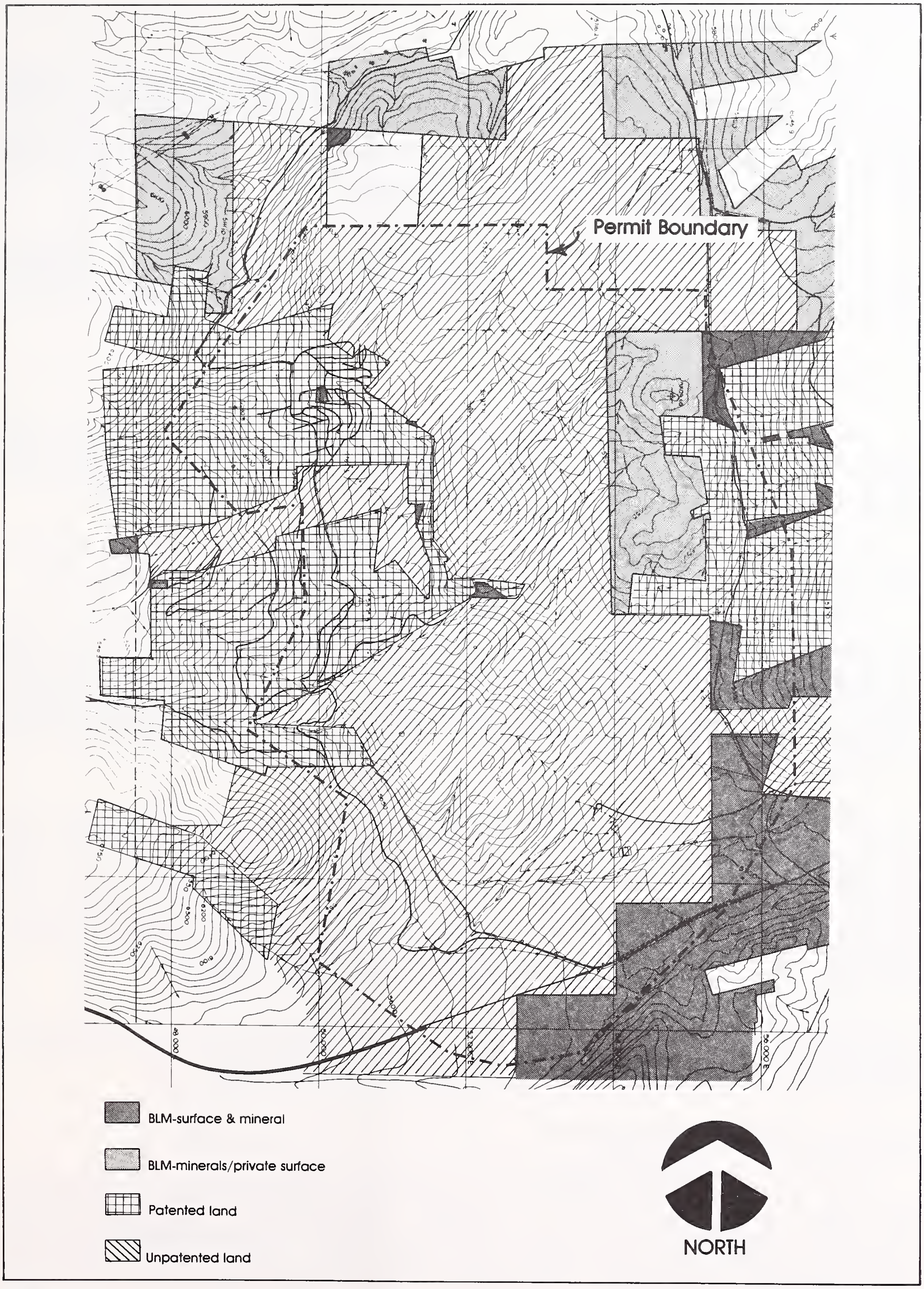


Figure II-1
Land within the permit boundary is privately held with the exception of some small parcels of BLM surface.

Fugitive particulate emissions would be generated from topsoil removal and handling, drilling and blasting ore, waste removal and handling, haul roads, access roads, and wind erosion of exposed areas. Operational practices used to control these emissions would include keeping fall distances during material handling to a minimum, chemically stabilizing haul roads, and watering some revegetated surfaces when possible.

The applicant has proposed to survey the pit walls to monitor movement. In addition, the applicant would stabilize the pit walls by using pumping wells to reduce water pressures. Before and during mining, studies would be done to define bench configuration and pit slope angles.

Waste Dump

Only a small portion of the waste rock would be used to construct the tailings dam; the remainder would be placed in a waste dump. Dumping would begin at the southern edge of the pit and advance to the south in a series of three separate lift terraces (see figure II-2).

After mining, the dump would cover 421 acres filling the lower half of Pen Yan Creek and extending onto the flat valley bottom of Wood Chute Creek.

The first lift terrace would start at an elevation of 5,740 feet near the pit and slope gently to the south. Trucks would end-dump the waste rock from the top of the lift, maintaining the predetermined shape and slope as dumping progresses. The outer edge of the first lift would reach 5,600 feet, a maximum of 250 feet above the existing landscape. The next lift would be smaller and stand about 170 feet high. The final lift would be about 130 feet high at an elevation of 5,900 feet.

Construction of each terrace would stop short of the final reclamation limits. Crawler tractor dozers would then push waste rock down the dump faces to reduce the outer dump slopes from 35 degrees--the natural angle at which the waste rock stacks--to the final reclaimed-slope gradient of 22 degrees (40 percent). The outer dump slopes of each lift would be retopsoiled and revegetated as soon as possible after regrading is completed. During operation of the mine and for a few years following final reclamation, runoff water from the waste dump would be retained temporarily in sediment ponds.

The three waste dump lifts would be separated by two relatively flat benches. The bench areas would allow vehicle access to the outer slopes of the dump for remedial reclamation and drainage-control work.

Ore Processing and Shipment

Ore would be taken by truck to an ore-processing plant next to the pit. The plant would consist of a crusher, concentrator, leaching circuit, refinery, lead and zinc flotation units, and other miscellaneous equipment. An office and change house, lab, truck repair shop, and warehouse would also be located with the plant. The plant would produce both gold and silver bullion and lead and zinc concentrates (figure II-3).

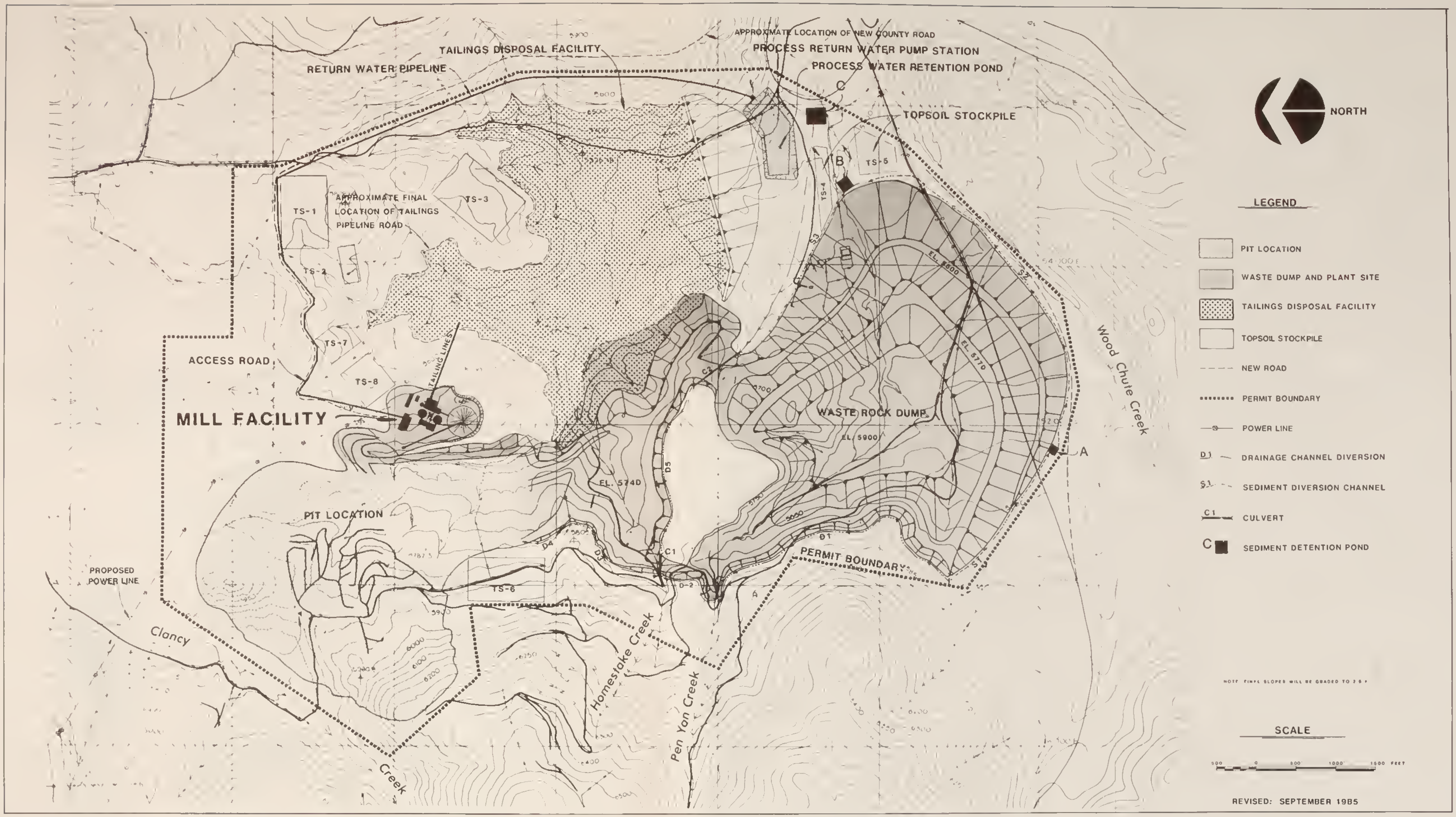


Figure II-2

This diagram details the plans of the applicant's proposed Montana Tunnels project, including the permit boundary.

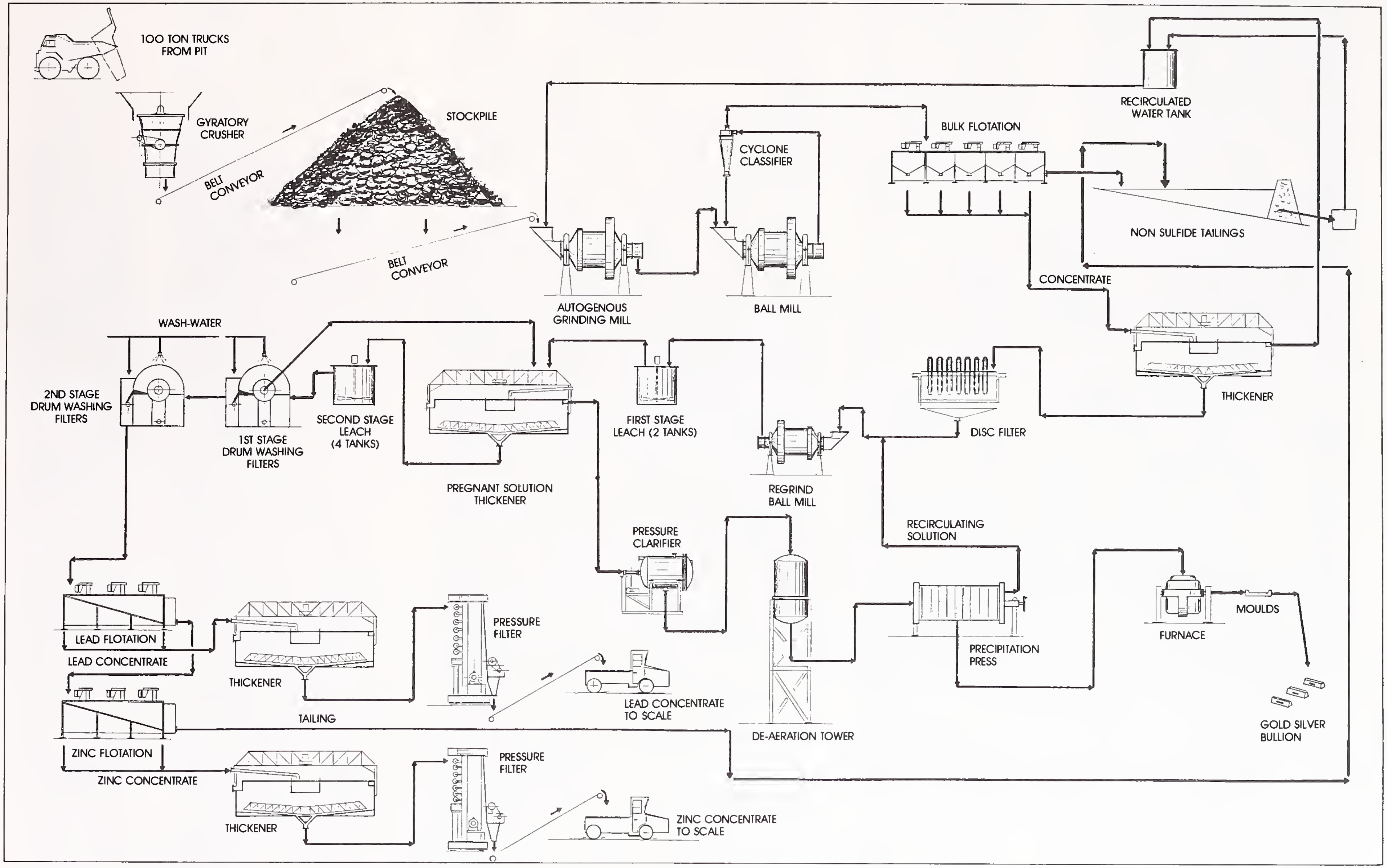


Figure II-3

Ore from the excavated pit would go through a complex processing system before the final products could be retrieved.

First-stage ore processing--including crushing, grinding, and bulk flotation--would produce a sulfide concentrate and waste tailings. The bulk flotation tailings would discharge to the tailings impoundment. The sulfide concentrate would be filtered and leached with cyanide solution to dissolve the gold and silver. The sulfide concentrate would be washed to recover the most cyanide possible. The dissolved gold and silver would be precipitated from the cyanide solution by zinc dust and then refined in a furnace to produce bars of bullion. The washed concentrate--consisting primarily of pyrite, galena, and sphalerite--would then be treated in a series of flotation processes. The flotation process would produce zinc and lead concentrates and sulfide waste tailings. The sulfide tailings would combine with the bulk flotation tailings and discharge to the tailings impoundment.

A variety of reagents standard to the industry would be used in ore processing. Reagents would include Xanthate, Aerofloat, copper sulfate, MIBC, Dowfroth, sodium silicate, Percol 351, sodium cyanide, zinc dust, lead nitrate, lime, and diatomaceous earth. Table II-2 lists the reagents that would be used in mineral processing, the addition points in the process, and the estimated annual consumption. Appendix 4 presents information regarding the physical characteristics and toxicity of each reagent.

Particulate emissions from the plant would be controlled through the use of wet scrubbing or baghouse systems. Plant emissions would result from crushing, screening, and conveying of ore. Particulate collection efficiency of the scrubbers and baghouse system should be 98 percent or more. Stringent emission and opacity limitations are placed on ore-processing facilities through federal air quality regulations (40 CFR Part 60, Subpart LL) implemented by the Montana Department of Health and Environmental Sciences (MDHES).

The lead and zinc concentrate would be shipped to Helena, either to ASARCO or to Burlington Northern rail loading facilities. The concentrate would be shipped on weekdays on day shift only. An estimated 290 tons per day (or 10 round trips per day) would be shipped in covered haul trucks. The trucks would travel the mine access road to the Jefferson City interchange with I-15, then north on the interstate, leaving the interstate at Helena (Townsend exit). The gold and silver bullion bars would be shipped to Helena by armored truck.

Tailings Disposal

The ore processing plant would produce waste material (tailings) at a rate of 14,280 tons per day of solids. About 93 percent of the tailings would be from the bulk flotation circuit. The other 7 percent would be tailings from the lead and zinc circuits. The combined tailings streams would be transported by water (28 percent solids content) to the tailings facility for disposal.

The tailings disposal facility is designed to continuously remove surface water and free-draining liquid from the tailings. By doing so, about 76 percent of the water from the tailings slurry would be reclaimed and recycled in the processing plant. The remaining 23 percent would be retained by the

Table II-2: List of Reagents Used in Mineral Processing

Reagent	Purpose	Addition point	Annual consumption (in tons)	Pounds per ton ore
Xanthate	Flotation collector	Bulk flotation and lead/zinc flotation	210	0.08
Aero 208	Flotation collector	Bulk flotation	158	0.06
Copper sulphate	Activator	Bulk flotation and lead/zinc flotation	446	0.17
MIBC	Frother	All flotation	393	0.15
Dow 250	Frother	All flotation	18	0.007
Sodium silicate	Dispersant	Lead flotation	499	0.19
Percol 351	Flocculant	Thickeners and filters	26	1.4
Zinc dust	Precipitation	Gold circuit	39	0.01
Lead nitrate	Precipitation	Gold circuit	10	0.004
Diatomaceous earth	Filtration	Gold circuit	52	0.02
Lime	pH control	Various points	10,237	3.89
Sodium cyanide	Gold circuit	Cyanide circuit	3,675	1.40

tailings material, or lost to evaporation or seepage. The facility design would minimize seepage discharges from the tailings during operations and, after mining, would provide a stable, drained tailings mass suitable for reclamation.

The tailings impoundment embankment and underdrainage system are the important structural features of the disposal facility. The embankment would be constructed of classified waste rock materials with different properties (grain sizes, permeability, and compaction characteristics). The embankment would be constructed to a static case safety factor of 1.4 on the upstream slope and 1.75 on the downstream slope (see figure II-4). A zone of fine-grained waste rock on the upstream face would allow accumulated water to flow into the embankment while retaining the tailings solids. The decanted water would flow downward within a coarse pervious zone towards an underseal beneath the upstream half of the embankment. On top of the seal a system of filter drains and perforated pipes would collect all drainage water and convey it in outlet pipes to the downstream toe, with gravity discharge into a retention pond (see Water Management). Water in the retention pond would be recycled back to the plant for reuse. Horizontal water movement through the embankment would be prevented with zones of sized weathered volcanic rocks placed in increasing layers of thickness behind the upstream, coarse pervious zone.

The underdrain system would be comprised of a filter and perforated pipework system installed on top of an underseal constructed by modification of native alluvial soils with bentonite clay (see figure II-3). The underdrainage system would gravity discharge and prevent the build-up of pore pressures in the tailings and hydrostatic pressure on the clay liner. Thus, the underdrain system would reduce seepage through the clay liner while maintaining a free-draining system in the tailings. The underdrain system would tie into the upstream toe of the main embankment and the outlet pipes beneath the embankment.

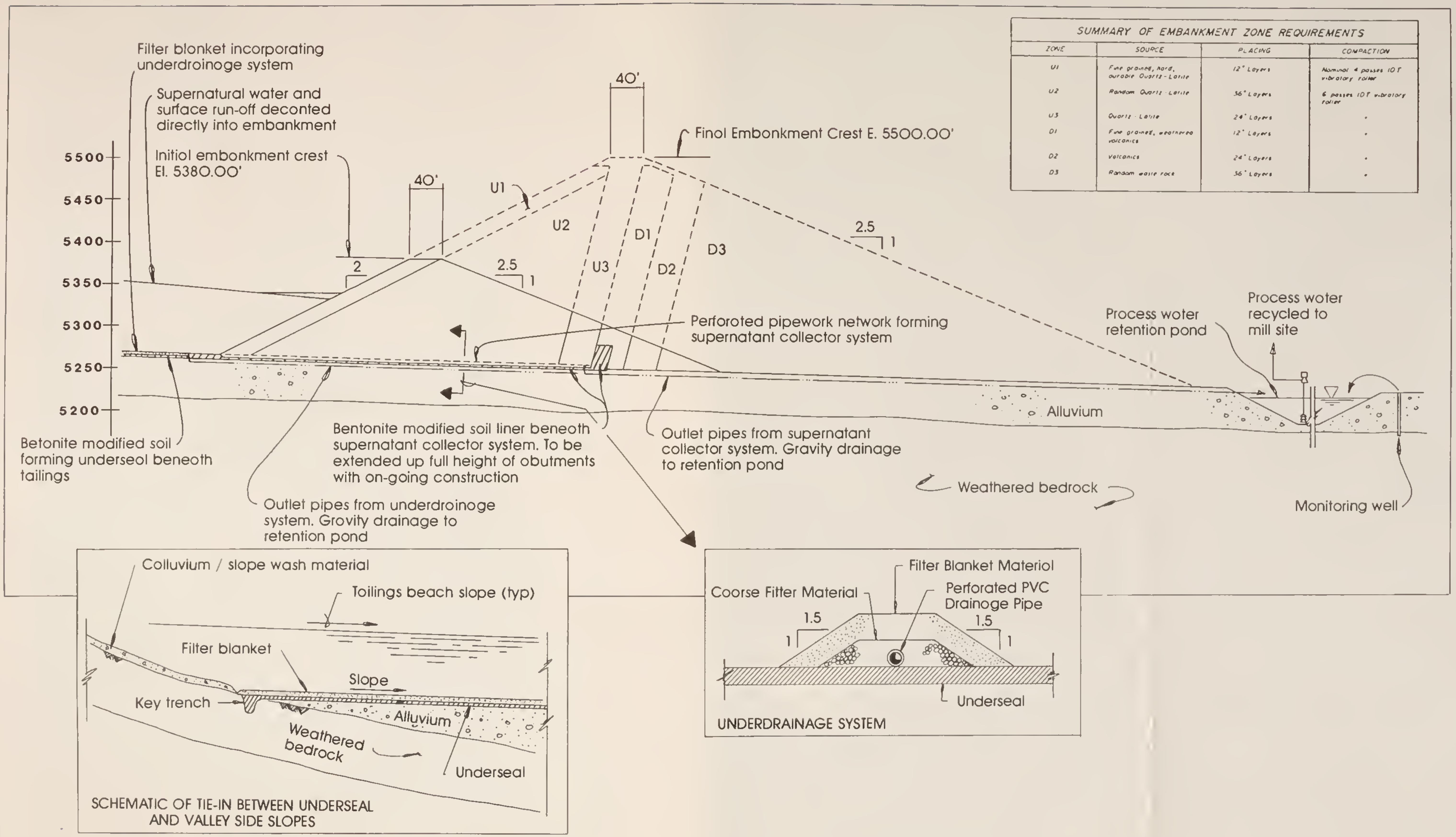
The tailings would be deposited around the impoundment perimeter in thin layers, forming an exposed surface (tailings beach) that would slope toward the embankment. The tailings discharge pipe system would be moved back from the dam in stages as the impoundment fills. An even depositional surface would be maintained by alternating the discharge points around the perimeter to allow part of the area to dry through drainage and evaporation while a new layer of tailings is deposited on the remainder of the area. Tailings discharge outside the perimeter of the underdrain system would be conveyed to the expanding tailings beach in lined ditches (see figure II-5).

This technique of tailings deposition would enhance liquid-solid separation during deposition and maximize subsequent air drying and consolidation of the tailings. The tailings laminations--characteristically of low permeability--would also decrease the overall seepage rate.

Wind-blown dust from the tailings surface would be controlled by increasing the frequency of alternating tailings discharge points during windy conditions to maintain a wet surface over the entire area. If necessary, all tailings discharge points can be used simultaneously to provide more coverage. The applicant has also committed to installing a water-sprinkling system if total coverage of the tailings surface cannot be maintained. In addition, the applicant would apply an annual seed mixture of wheat or barley as the tailings surface dries.

Water Use and Management

Total water required for the operation is estimated to be 6,223 gallons per minute. Of this, 5,305 gallons per minute would be recycled and, on the average, an additional 918 gallons per minute would be obtained from various sources including Spring Creek surface water and ground water, existing mine discharges, and inflow to the open pit. Approximately 600 to 900 gallons per minute would be depleted from the Spring Creek system depending on the volume being supplied by other surface and ground-water sources at the mine site. Flow rates greater than 918 gallons per minute would be required during mine start up.


Filter blanket incorporating underdrainage system
Supernatural water and surface run-off decanted directly into embankment
Initial embankment crest El. 5380.00'
40'
40'
Final Embankment Crest E. 5500.00'
U1
U2
U3
D1
D2
D3
2
2.5
1
2.5
1
5500
5450
5400
5350
5300
5250
5200
Perforated pipework network forming supernatant collector system
Process water retention pond
Process water recycled to mill site
Alluvium
Betonite modified soil forming underseal beneath tailings
Bentonite modified soil liner beneath supernatant collector system. To be extended up full height of abutments with on-going construction
Outlet pipes from supernatant collector system. Gravity drainage to retention pond
Weathered bedrock
Monitoring well
Outlet pipes from underdrainage system. Gravity drainage to retention pond
Colluvium / slope wash material
Tailings beach slope (typ)
Filter blanket
Slope
Key trench
Alluvium
Weathered bedrock
Underseal
SCHEMATIC OF TIE-IN BETWEEN UNDERSEAL AND VALLEY SIDE SLOPES
Filter Blanket Material
Coarse Filter Material
Perforated PVC Drainage Pipe
1.5
1
1.5
1
Underseal
UNDERDRAINAGE SYSTEM

SUMMARY OF EMBANKMENT ZONE REQUIREMENTS

ZONE	SOURCE	PLACING	COMPACTION
U1	Fine grained, hard, durable Quartz-Latite	12" Layers	Nominal 4 passes 10T vibratory roller
U2	Random Quartz-Latite	36" Layers	6 passes 10T vibratory roller
U3	Quartz-Latite	24" Layers	"
D1	Fine grained, weathered volcanics	12" Layers	"
D2	Volcanics	24" Layers	"
D3	Random waste rock	36" Layers	"

Figure II-4

The tailings disposal system would feature an embankment constructed of sorted waste rock, an underseal and underdrainage network, and a retention pond to capture and recycle process water.

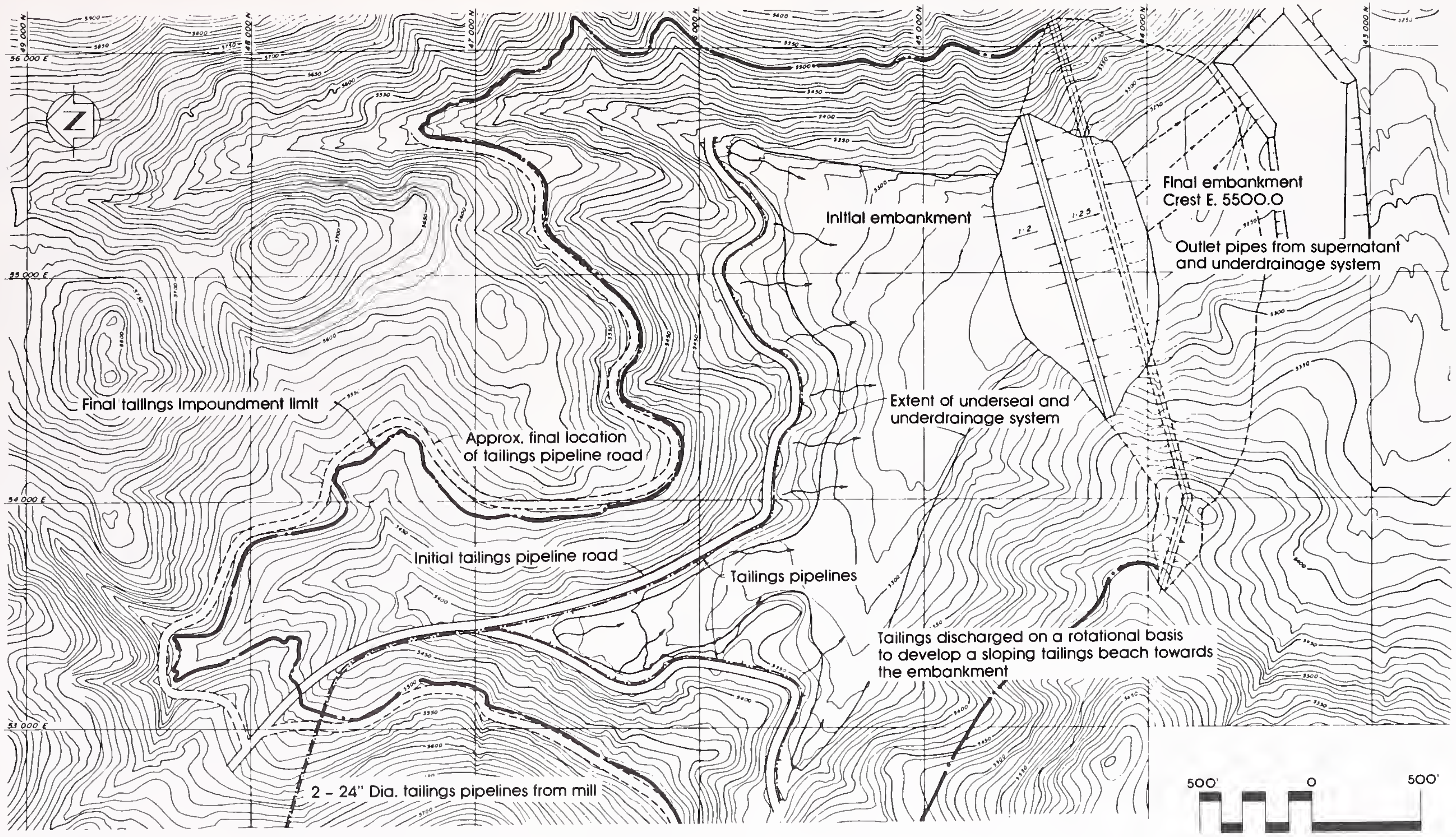

49 000 N
48 000 N
47 000 N
46 000 N
45 000 N
44 000 N
43 000 N
56 000 E
55 000 E
54 000 E
53 000 E
N
Final embankment
Crest E. 5500.0
Initial embankment
Outlet pipes from supernatant and underdrainage system
1:2
1:2.5
Final tailings impoundment limit
Approx. final location of tailings pipeline road
Extent of underseal and underdrainage system
Initial tailings pipeline road
Tailings pipelines
Tailings discharged on a rotational basis to develop a sloping tailings beach towards the embankment
2 - 24" Dia. tailings pipelines from mill
500'
0
500'

Figure II-5
This diagram details the progress of the tailings impoundment throughout the life of the mine.

The 250-acre-feet capacity, water-retention pond would be riprapped on the sides to prevent erosion and would be constructed with a bentonite-modified soil liner. The pond would maintain a reserve capacity for a 100-year, 24-hour storm event. An emergency spillway would be established two feet below the crest elevation of the pond embankment and the retention pond would be provided with a pump station to return water to the mill.

Water from the retention pond would be returned to the plant through an 18-inch pipeline. Provision would be made for a wide variation in return water flows to allow for optimum use of water in the process-water retention pond. Flow and pressure sensors would be provided on the pumps and pipelines to monitor performance and to indicate possible malfunction. A significant portion of the return water pipeline would be located within the tailings disposal facility catchment and waste water from any pipeline leaks would be directed toward the retention pond.

Recovery wells would be constructed down gradient of the water retention pond to monitor ground water quality and intercept seepage that may move through the base of the impoundment. Water pumped from the recovery wells will be diverted to the process-water retention pond.

Sewage generated during the mining phase would be treated through a package treatment plant. The treated effluent would be discharged to the tailings impoundment.

Runoff and Sediment Control

During operation of the mine, runoff from all disturbed areas would be collected in the sediment ponds or the tailings impoundment. Except for large flood flow events, all collected surface water would be used as make-up water in the process plant.

Runoff in Pen Yan and Homestake creeks above the waste rock dumps would be diverted through the center of the waste rock dump in open-channel ditches and buried culverts to an unnamed ephemeral drainage located between the waste dump and tailings impoundment (see figure II-2). Runoff from the western edge of the waste rock dump would be directed into the Homestake/Pen Yan diversion or to the open-pit excavation. Runoff from the outer slopes of the waste dump would be collected by small open-channel diversion ditches located along the base of the waste dump. All diversion structures would be constructed to carry flood flows for a 100-year, 24-hour precipitation event. Three sediment-retention ponds would collect runoff from disturbed areas outside the tailings impoundment. These ponds would trap suspended sediment in the runoff water. Runoff greater than a 10-year, 24-hour event would be discharged from the sediment retention ponds to prevent structural damage of the ponds.

During operations, the diversion and sediment-control structures would be maintained and modified as necessary. Some disturbance areas would be revegetated while the mine operates. Following the completion of each waste rock dump level, the final revegetation species would be planted. Interim seed mixes (table II-3) have been developed to stabilize other disturbance areas until final revegetation.

Table II-3: Interim Seed Mixtures

	Topsoil stockpiles		Tailings dump		All other areas	
Common Name[1]	Rate (pure live seed)[2]	Percent of mixture[3]	Rate (pure live seed)[2]	Percent of mixture	Rate (pure live seed)[2]	Percent of mixture[3]
Wheat or barley	0.0 lbs/acre	0	16 lbs/acre	100	0.0 lbs/acre	0
Timothy	2.0 lbs/acre	27	0 lbs/acre	0	0.0 lbs/acre	0
Canada bluegrass	1.0 lbs/acre	29	0 lbs/acre	0	1.0 lbs/acre	32
Smooth brome	8.0 lbs/acre	13	0 lbs/acre	0	8.0 lbs/acre	14
White clover	4.0 lbs/acre	31	0 lbs/acre	0	3.0 lbs/acre	26
Slender wheatgrass	0.0 lbs/acre	0	0 lbs/acre	0	8.0 lbs/acre	13
Crested wheatgrass	0.0 lbs/acre	0	0 lbs/acre	0	4.0 lbs/acre	15
TOTALS	15.0 lbs/acre	100	16 lbs/acre	100	24.0 lbs/acre	100

Source: Project application, 1984.

[1] See Appendix 5 for scientific names.

[2] Broadcast or hydroseeding would be used.

[3] Based on pure live seed per square foot.

Utilities

Montana Power Company's Helena-to-Butte, 100-kilovolt (kV) transmission line is located about one mile from the plant site. MPC would construct a new line to connect the plant site with the 100-kV power line on the north side of Clancy Creek. The line and towers would incorporate features for raptor protection as described by the Rural Electrification Administration (1978).

Roads

The existing county road that joins Interstate-15 (I-15) at Jefferson City and connects both Corbin and Wickes would be the primary mine access road (figure II-6). In addition to the project employees, the county road would be used for delivering supplies and transporting concentrate, which would be scheduled weekdays for day shifts only. Worker traffic would occur before and after shift changes. The applicant would support a cost-effective bus service to the site for its employees or encourage carpooling. The applicant would also apply a chemical stabilizer to the road surface to reduce dust emissions from project traffic.

Centennial would relocate the county road in two places and provide a one-way, in/out access at Jefferson City. The road would be paved through Jefferson City. Between Jefferson City and the Centennial Ranch (the old Munson Ranch) the road would be straightened and leveled. A bypass would be constructed to the south of Corbin, rejoining the Corbin-Wickes road just west of Corbin. The bypass road would be built of new road material laid down on top of the old tailings. North of Wickes, the existing county road would be

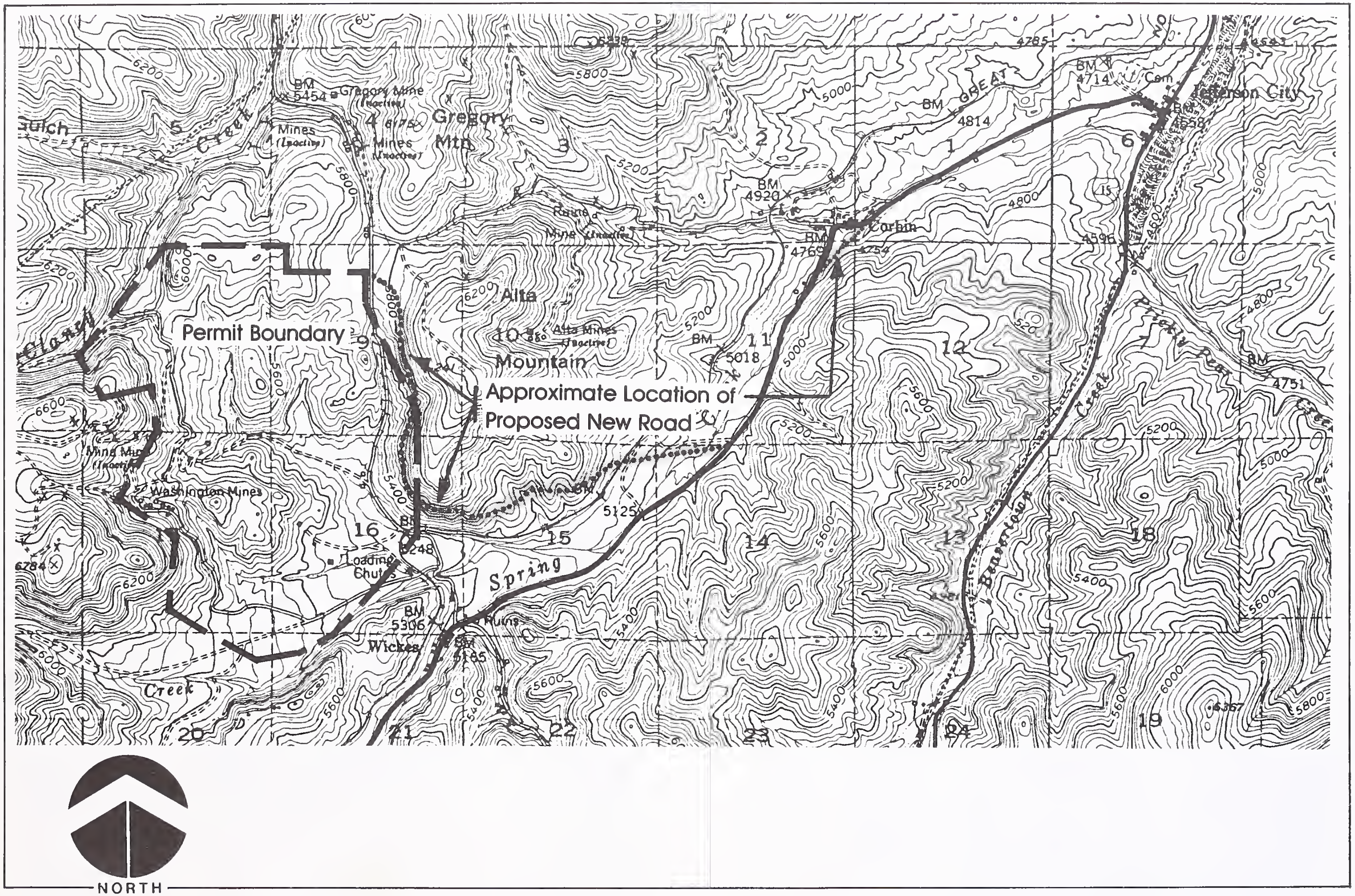


Figure II-6

The applicant plans to build a new segment of road to bypass the community of Corbin. Another new road would follow the southern contours of Alta Mountain and would also route mine traffic around Wickes.

covered by the tailings impoundment at the base of Alta Mountain. This section of road would be replaced with a new county road that would be constructed around the south and west sides of Alta Mountain. The new road would connect the Corbin-Wickes road south of Wickes and would provide connection with the Clancy Creek Road.

The waste dump would eventually encroach on the Wood Chute road, forcing relocation of the road a short distance to the south, yet still on the alluvial plain. No interruption of access would occur.

Mine Employment and Economic Impact Mitigation

The applicant would hire 200 construction workers the first quarter. Employment would peak at 551 temporary jobs during the quarter of peak construction activity. Up to 340 jobs would be provided annually during peak operations over the 12- to 13-year life of the mine. Construction is expected to begin March 1, 1986 and last five quarters. The applicant expects to begin production at the project site in July 1987 and to employ 232 workers during the first three years of operation. Mine stripping ratios would increase the fourth year of production, necessitating hiring 108 more employees (340 total). In 1997, the applicant plans to begin reclamation and demolition of the project. Employment would fall to 116 employees and decrease to three workers before final closure in 1998 (see Chapter IV--Employment for a more detailed schedule of project employment). The applicant has stated its intent to hire as many local area employees as possible. Workers would be hired from Jefferson, Lewis and Clark, and Silver Bow counties.

The largest work forces would be the Monday-through-Friday day shift (182 employees) and the Saturday and Sunday shifts (103 employees). The evening and graveyard shifts would use 48 and 47 employees.

Hard-Rock Mine Impact Mitigation Plan

The applicant has prepared a hard-rock mine impact mitigation plan as required by Montana state law. The plan addresses possible impacts to Jefferson County and other units of local government within the county. The plan was reviewed by the governing boards of the affected jurisdictions. The final plan approves about $300,000 in impact mitigation assistance with the applicant's agreement to provide additional assistance if some jurisdictions receive a greater impact than anticipated.

The impact plan is based on the assumption that no less than 80 percent of the work force would be hired from Jefferson, Silver Bow, and Lewis and Clark counties except during the third quarter of construction, when only 70 percent would be hired locally. Of those hired locally, 50 percent are projected to live in and commute from Butte throughout the life of the project. The other half of the locally hired work force is expected to come from Jefferson County (12.5 percent), and Lewis and Clark County (37.5 percent). The plan also assumes that, during construction, one half (up to 83) of the incoming construction workers would live in Jefferson County while the other half would live in Lewis and Clark County. Each nonlocal construction hire is estimated to cause an influx of an additional 2.3 people, which would result in a total temporary peak construction population increase in each county of 191 people, of whom 83 would be school-aged. During the operations phase, it is assumed in the impact plan analysis that one-quarter of the newcomers hired by the applicant would settle in Jefferson County. Lewis and Clark County is predicted to receive three-fourths of project-worker in-migrants. Operations workers are expected to bring an additional 3.84 people per non-local hire. At peak operations employment, such assumptions mean that 65 people would move to Jefferson County--17 workers with 20 school-aged children, 8 preschool-aged children, and 20 other adults. Project population increases in Lewis and Clark County using the same assumptions would cause a 196-person increase; 51 of these would be workers, 59 school-aged children, 26 preschool-aged children, and 60 would be other adults. Such population estimates do not include in-migration due to workers seeking secondary employment induced by the mine (Mountain International, Inc., 1985, p. 78). The impact plan assumes that all workers hired from Butte would remain in Silver Bow County.

Table II-4 shows a synopsis of the impact mitigation that the applicant would pay Jefferson County and other jurisdictions and organizations within the county. The applicant has agreed to provide up to $300,000 in initial impact assistance. About $65,000 of that amount may be tax prepayments that would be credited against future tax liabilities. The balance is donations made by the applicant to each entity. Table II-4 does not include impact assistance that the applicant has agreed to pay to the school districts. Such amounts will be determined on the number of project-worker school children enrolled in each district. Unless otherwise specified, all of the following discussion is drawn from the Montana Tunnels Hard-Rock Mine Impact Mitigation Plan for Jefferson County.

The applicant has agreed to pay the county $10,000 for deposit into an impact contingency fund. The fund would be administered by the Jefferson County commissioners. Any of the jurisdictions and organizations listed in table II-4 can apply for additional impact assistance from the contingency fund. If all the contingency fund were spent, the applicant may contribute additional money upon mutual consent of the county and the applicant. Spending from the contingency fund would be credited as tax prepayments if the payment went to an entity that levied taxes on company property. Otherwise, contingency fund payments would be considered donations.

According to the impact plan, the applicant can receive tax credits beginning in the second fiscal year of commercial mining operations. Annual tax credits would be limited to $10,000 or 15 percent of the tax prepayment, whichever is greater. Such limits apply to each tax revenue fund and not the total company tax bill. For instance, the applicant could receive the maximum credit against the amount payable to the road fund, the amount payable to the Clancy Elementary School District #1, and the amount payable to the county general fund. After seven years from the start of commercial mining operations, if the applicant does not own property in an affected jurisdiction against which tax credits could be claimed, the applicant has agreed that all previous impact payments would be considered donations.

The impact plan establishes a monitoring committee composed of one representative from the applicant, the prime construction contractor, Jefferson

Table II-4: Summary of Monetary Contributions and Tax Prepayments Included in the Montana Tunnels Impact Mitigation Plan for Jefferson County

Jurisdiction	Type of assistance	Amount
Jefferson County		
Contingency fund	Tax prepayment or donation[1]	$ 10,000
County road construction	Tax prepayment	50,000
	Donation	181,000
County road maintenance	Tax prepayment (annual)	15,000
Law enforcement communications	Donation	18,000
Jefferson County solid waste district	Donation (570) from the contingency fund	--
Town of Boulder		
Water supply and waste water treatment	Monitor impacts	
Boulder fire department	Donation	250
Ambulance service	Donation	5,000
	Donation (annual)	1,000
Clancy Quick Response Unit	Donation	2,500
	Donation (annual)	250
Jefferson City volunteer fire department	Donation	15,000
	Donation (annual)	1,000
Montana City rural fire district	Donation	250
Clancy volunteer fire department	Donation	250
Boulder valley rural fire district	Donation	250
Montana City Elementary School district #27	Monitor impacts	--
Clancy Elementary School district #1	Monitor impacts	--
Boulder Elementary School district #7	Monitor impacts	--
Jefferson High School district #1	Monitor impacts	--
TOTAL		$299,750

Source: Mountain International, 1985.

[1] Expenditures from the contingency fund would be credited as either tax prepayments or donations depending on the entity receiving the payment. The applicant would receive tax credits if payments were made to jurisdictions that impose taxes on company property, otherwise disbursements would be considered donations.

[2] The total impact assistance amount may be larger, depending on evidence of and payment for impacts to the school districts and to the town of Boulder for water supply and waste water treatment. Of the $300,000 listed in the table, $225,000 would be contributed by the applicant as a donation to the respective jurisdiction.

County, Boulder, the Clancy school district, the Montana City school district, and the Boulder school districts. This committee would monitor employee location throughout the impact period, defined as 60 days before the start of construction until the time when the applicant has made the first property tax payment following the commencement of commercial mining operations. The committee would design the monitoring questionnaire, review the information gathered from the employee monitoring process, inform local jurisdictions of the project employment, social, and demographic trends, and assist in development of impact plan amendments if necessary.

The town of Boulder and affected school districts (Clancy elementary, Montana City elementary, Boulder elementary, and Jefferson County high school) may receive impact assistance from the applicant. The monitoring committee would periodically assess possible impacts on the water supply and waste-water treatment systems of the town of Boulder. If more project workers were to locate in Boulder than estimated and cause impacts to occur, the town could apply for assistance from the contingency fund.

The monitoring committee would also contact the Jefferson County Solid Waste District periodically to assess whether the project causes waste disposal or collection problems. The district may receive $570.00 from the contingency fund upon application and may seek additional assistance from the contingency fund. Although the applicant plans to operate its own private landfill, it would negotiate a standby agreement with the district in the event waste disposal at the project site is not practical.

School districts would determine the number of new students enrolling in each school because of the mine. Upon written notification, the applicant would pay the district within 30 days, an amount equal to the sum of the foundation and permissive payments for each student based on the school foundation schedules in effect at the time of student registration. If the student enrolls after the beginning of the school year, payments would be prorated over the remainder of the year. The applicant would reimburse school districts for the cost of education for each in-migrating mine student who is handicapped or developmentally disabled, less payments made by federal and state agencies to the district for such purposes. School districts may receive such payments throughout the impact period (60 days before the start of construction until the applicant makes its first property tax payment after commencement of commercial mine operations). The Clancy elementary and Jefferson County high school districts are the only school districts that can levy property taxes on company property. If other school districts should experience greater fiscal impact than estimated after the impact period has passed, the districts could petition the county commissioners or the Hard-Rock Impact Board to implement the tax-based sharing provisions of the Hard-Rock Mine Impact Act in order to alleviate revenue short falls. The monitoring committee would make such a decision if jurisdictional revenue disparities become apparent before the end of the impact period.

During the impact period, if any school board decides to split classes, hire additional teachers and staff, or add additional classrooms, the applicant would pay a prorated share of such costs based on the number of in-migrating mine students. The applicant has agreed to pay a prorated share of the expense of temporary facilities if such facilities are necessary during the impact period.

Table II-4 shows the monetary donations that the applicant would make to the fire departments within the county. In addition to these donations, the applicant would periodically provide a list of equipment available for loan and use in fire suppression. The applicant would establish a fire protection advisory committee in order to advise the applicant on fire protection activities in the county, including equipment needs. The impact plan also specifies that the applicant would reimburse fire departments for reasonable costs incurred while responding to fire calls at the project site. Fire departments would be invited to attend all company-sponsored emergency training sessions.

According to the impact plan, the applicant would provide monetary and other types of assistance to both the Clancy Quick Response Unit and the Boulder Ambulance. The applicant will negotiate a mutual aid agreement with both organizations to supply backup emergency medical support for the project; even though the applicant intends to hire or train emergency medical technicians and to have its own ambulance. The applicant would reimburse the Boulder Ambulance for calls it makes to the project site. The applicant would provide backup support to the ambulance service for major accidents occurring within 15 miles or so of the mine. The applicant would provide the ambulance service with a list of equipment available on a loan basis (see also table II-4).

Bonding

The applicant must file a bond with the Department of State Lands (DSL) of not less than $200 and not more than $2,500 for each acre disturbed. Despite these limits, however, the bond must not be less than the estimated cost to the state of reclaiming the disturbed lands (82-4-328[1], MCA). The bond would not be released until DSL determined that reclamation has been successfully completed.

Reclamation

The applicant's stated objective in its reclamation plan is to achieve a suitable and practical postmining land use. The objective includes:

--restoring the land for livestock and wildlife grazing,
--restoring wildlife habitats,
--providing permanent protection of area air and water resources,
--restoring the disturbed areas for public recreation, and
--removing public hazards.

To accomplish its objectives, the applicant would stabilize all disturbed areas, except the pit, as soon as practical during operations. After mining, all disturbed areas would be reclaimed including the waste dumps, haul and access roads, tailings impoundment, and plant site.

The applicant considered for its reclamation plan the characteristics of the waste rock and tailings, environmental baseline studies (such as soils, geology, hydrology, vegetation), and would also consider future test plot studies during operations and monitoring. Except for the environmental baseline studies, each of these considerations are described in this section as part of the reclamation procedures. The environmental baseline studies are described in detail in Chapter III.

Characteristics of Waste Materials: Four types of waste rock and two types of tailings would be produced by the Montana Tunnels project (see table II-5 for soil types). The four waste rock types are sub-ore grade diatreme, quartz latite dike, Lowland Creek volcanics, and Elkhorn Mountain volcanics. These materials would all be placed in the waste rock dump shown on figure II-4. Bulk flotation and sulfide tailings would be combined before discharge into the tailings disposal facility (figure II-4). Table II-6 lists the chemical and physical characteristics of these waste products.

The Elkhorn Mountain volcanics and Lowland Creek volcanics are lowest in trace elements (see table II-6) followed by the quartz latite dike material. All three of these materials have a net neutralization potential. The sub-ore grade diatreme material has a high sulfide content and a net acid-generating potential, as well as relatively high values for some of the trace elements. The bulk flotation tailings have low concentrations for most of the trace elements; the sulfide tailings have relatively high concentrations. Both types of tailings have a net acid-generating potential and silty texture.

Postmining Topography and Drainage Control: With the exception of the 162-acre pit all disturbed areas would be graded to blend with the surrounding, undisturbed topography. Grading would generally be conducted with tracked dozers. Figure II-7 shows the proposed postmining contours.

Waste rock dump slopes would be graded to 2.5:1 (40 percent) to reduce the erosion potential of the redistributed soils. Waste dump levels would be reclaimed incrementally, allowing DSL and the applicant to evaluate reclamation success on these slopes early in the operation. If problems appear, the applicant would consult with DSL and additional reclamation measures would be implemented. The tops of the waste rock dumps would be relatively flat, with less than 2 percent slopes. Dump tops would be graded to eliminate depressions and provide surface water flow away from the steeper dump sideslopes. This grading is intended to reduce rilling and gullying on the sideslopes and reduce infiltration into the dump. Shallow drainageways on the dump tops would direct flow to undisturbed ground.

Following reclamation, the three sediment ponds would be removed. The combined runoff of Pen Yan and Homestake creeks would be permanently diverted through the center of the waste rock dump in two open channels. Coarse-textured, non-toxic waste rock (Elkhorn and Lowland creek volcanics) would be placed in the drainages. Where possible, the channel would be cut into bedrock to help control erosional downcutting. Large-textured riprap would be placed in diversion channels where peak flood flows might initiate erosion. The Homestake/Pen Yan diversion would lead to a natural ephemeral drainage located between the waste dump and the tailings impoundment. From there, runoff water would flow into the existing Homestake channel.

The surface of the tailings impoundment would have a one-percent slope toward the embankment before grading and soil redistribution. A surface water drainage system would be developed to direct runoff water over the tailings surface to a runoff channel located along the western abutment of the tailings dam (figure II-7). This is intended to prevent ponding on the final surface. A portion of the western edge of the tailings impoundment would be covered with waste rock as a result of reducing the waste rock dump slopes to 2.5:1.

Table II-5: Soil Resources of the Proposed Disturbance Area Available for Reclamation

Soil mapping unit[1]	Acres proposed for disturbance	Percent of total disturbance area	Proposed total salvageable depth (inches)	Salvageable soil volume (acre-feet)	Percent of total salvageable volume	Primary factors limiting deeper salvage
A sandy loam, 25-50%	27	2.9	25	56.2	5.5	excess coarse fragments
A1 sandy loam, 25-50%	9	1.0	15	11.3	1.1	excess coarse fragments
B sandy loam, 0-25%	16[2]	1.7	53[2]	68.2	6.6	excess coarse fragments
B disturbed soil, 0-25%	17	1.8	0	0.0	0.0	excess trace elements
C gravelly sandy loam, 25-50%	71	7.8	16	94.7	9.2	excess coarse fragments
D sandy loam, 35-70%	40	4.4	19	63.3	6.1	excess coarse fragments, steep slopes
D-rock outcrop complex, 35-70%	123	13.5	0[3]	0.0[3]	0.0	rock outcrops, steep slopes, excess coarse fragments
E gravelly sandy loam, 5-35%	267	29.3	13	289.2	28.1	excess coarse fragments
Est gravelly sandy loam, 35-70%	13	1.4	0[3]	0.0[3]	0.0	steep slopes, excess coarse fragments
F gravelly sandy loam, 35-70%	6	0.7	19	9.5	0.9	excess coarse fragments
G gravelly, cobbly loam, >50%	7	0.8	0	0.0	0.0	excess coarse fragments
J gravelly loamy sand, 20-40%	26	2.9	0	0.0	0.0	excess trace elements, excess sand
J1 gravelly sandy loam, 25-50%	49	5.4	0	0.0	0.0	excess trace elements
M sandy loam, 0-15%	48[2]	5.3	40[2]	97.0	9.4	excess coarse fragments
R gravelly sandy loam, 0-15%	145	15.9	24	290.0	28.2	excess coarse fragments
T cobbly, very gravelly sandy loam, 25-50%	2	0.2	0	0.0	0.0	excess coarse fragments
W sandy clay loam, 15-35%	10	1.1	60	50.0	4.9	excess coarse fragments, excess sand
FEA complex, 35-70%	36	3.9	0[3]	0.0[3]	0.0	steep slopes
TOTAL	912	100.0		1,029.4	100.0	

Source: Montana Tunnels permit application, 1984.

[1] The soils in this survey were named using letters of the alphabet to avoid any potential conflict with official Soil Conservation Service soil series names. Percentage figures following mapping unit names represent slope ranges where unit is found.

[2] 1.2 acres of B soil in the area of the tailings impoundment would be salvaged to a depth of 28 inches; 23.6 acres of M soil would be salvaged to a depth of 8 inches. The remaining fine-grained soil in these two areas would be utilized for the bentonite/soils liner beneath the tailings.

[3] Although not indicated in this table, some soils from the D-Rock Outcrop complex, the Est unit, and the FEA complex would be salvaged. Criteria for salvage in these units are: 1) accessible slopes of less than 50 percent that pose no danger to equipment or operators; 2) sufficient contiguous salvageable area to make salvage feasible; and 3) accessibility to haul routes.

Table II-6: Characteristics of Montana Tunnels Ore and Waste Materials

Material	Volume (mcy)[1]	Texture	Cadmium	Nickel	Zinc	Lead	Copper	Manganese	Mercury	Arsenic	Aluminum	Selenium	Sulfide Sulfur	Acid Generation Potential[2]	Neutralization Potential[3]	Acid-Base Balance[4]
			parts per million										(percent)			
Ore Type[5]																
Diatreme ore (bulk composite)	--	--	80	50	9,600	3,000	600	270	0.6	46.0	77,700	--	--	--	--	--
Waste Rock Types[6]																
Quartz latite dike	12.0	very cobbly, sandy loam	0.017	0.05	0.46	0.14	0.07	51.40	<0.0001	<0.005	<0.1	0.001	0.27	8.4	57.1	+48.7
Sub-ore grade diatreme	30.0	very cobbly, sandy loam	0.021	0.02	5.80	17.20	0.05	18.10	<0.0001	<0.005	1.2	<0.001	1.19	37.2	15.5	-21.7
Lowland Creek volcanics	71.0	very stony, cobbly, sandy loam	0.015	0.03	3.77	0.03	0.04	4.28	<0.0001	<0.005	0.1	<0.001	0.10	3.1	8.1	+5.0
Elkhorn Mountain volcanics	5.9	very stony, cobbly, sandy loam	0.013	0.05	0.22	0.17	0.07	4.82	<0.0001	<0.005	0.2	<0.001	0.08	2.5	12.0	+9.5
Tailings Types[6]																
Bulk flotation tailings	7.8	very silty or clayey	0.930	0.05	1.95	0.12	0.08	0.80	<0.0001	<0.005	0.1	<0.001	0.18	5.6	1.9	-3.7
Sulfide tailings	0.9	very silty or clayey	3.480	0.12	63.90	6.03	0.04	3.13	<0.0001	<0.005	<0.1	<0.001	35.20	1,099	0	-1,099

Source: Montana Tunnels permit application, 1984.

[1] million cubic yards.

[2] Presented as tons of calcium carbonate equivalent (required to neutralize the acid) per 1,000 tons of waste material.

[3] Presented as tons of calcium carbonate equivalent per 1,000 tons of waste material.

[4] This is the difference between the acid generation potential and the neutralization potential. A "+" indicates a net neutralization potential, whereas a "-" indicates a net acid-producing potential.

[5] Ore values presented are total concentrations.

[6] Arsenic, aluminum, and selenium were extracted using hot water with a 1:5 solids to liquid ratio. The remaining trace elements were extracted using a weak acid (EP Toxicity) with a 1:20 solids to liquid ratio. Sulfide sulfur was determined using a LECO furnace.

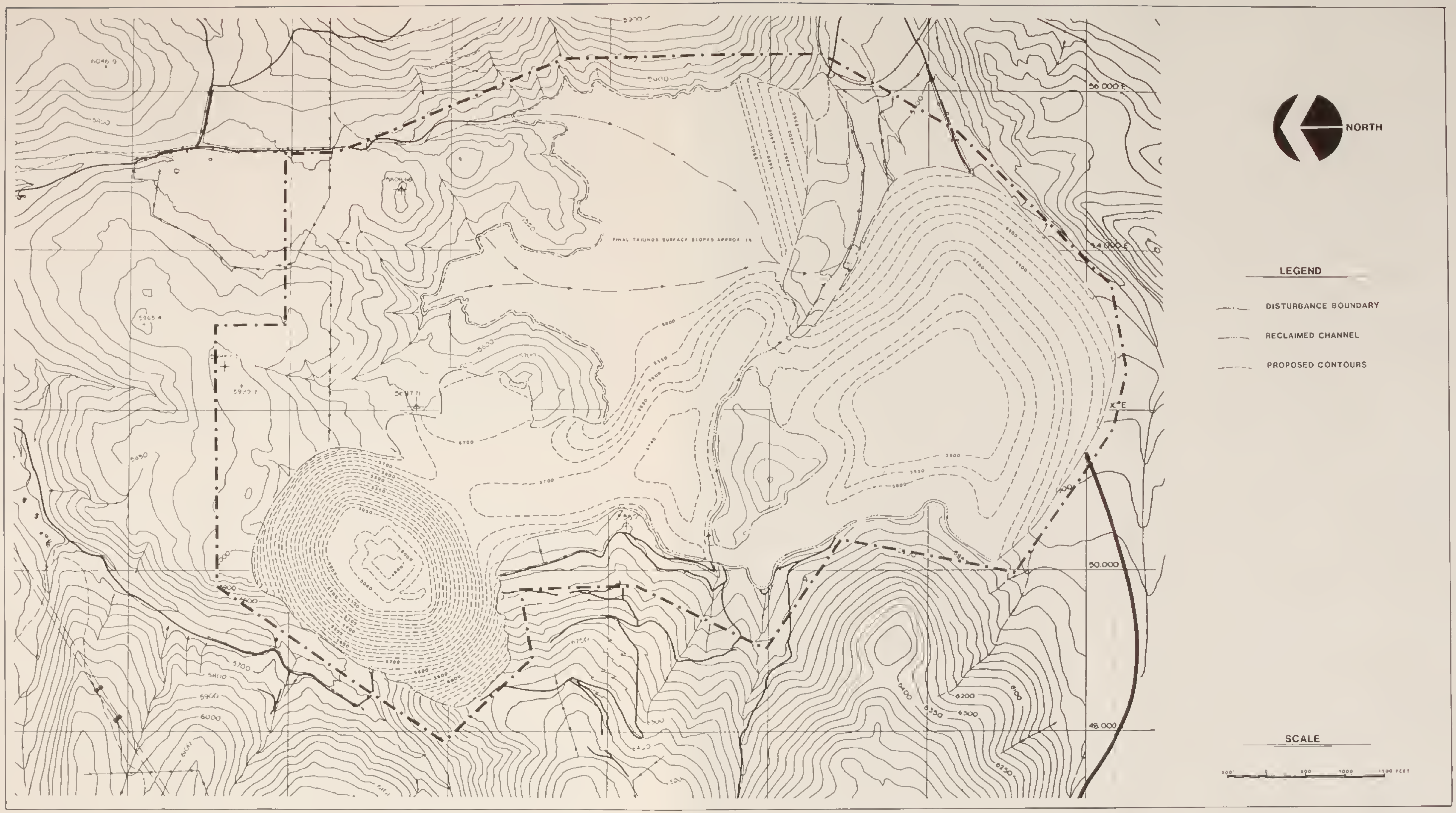


Figure II-7

After mining, the disturbed areas would be graded to blend with the surrounding topography and produce a functional postmining landscape.

In order to reduce potential impacts from wind, the surface of the impoundment would be graded to create some minor topographic diversity.

Minimal settling of the waste rock dump and tailings impoundment is expected over time. Operational monitoring would be used to predict postoperational consolidation of the tailings. Should predicted settling be great enough to affect the postmining drainage system or cause internal depressions, the areas would be mounded to compensate for the settlement. At the end of mine operations, a small quantity of on-going seepage from the underdrainage system would continue until the tailings became consolidated in the deepest portion of the facility.

The facilities area, soil stockpile sites, roads, and sediment-control structures would be graded to resemble the original contours (figure II-7).

Soil Salvage and Handling Plan: Soils would be salvaged from all disturbed areas except the soil stockpile sites. For each soil mapping unit, proposed soil salvage depths and volumes are presented in table II-5. Approximately 1,029 acre-feet of soil would be salvaged from the proposed 912-acre disturbance area. Soil would be redistributed over 750 acres to a uniform depth of about 17 inches. (Soil would not be replaced on the 162 acres of pit disturbance; therefore, 912-162=750 acres.) Approximately 66 acre-feet of soil from the B and M soil series would be used for the bentonite/soil liner beneath the tailings disposal facility. Soil salvage recommendations include deeper horizons containing between 35 and 50 percent coarse fragments. These coarser subsoils would be segregated in the stockpiles, with the coarser soils being placed at one end.

Soil suitability for reclamation was determined from physical and chemical data collected during the baseline soil survey. Physical parameters included depth, slope percentage, saturation percentage, texture, permeability, organic matter content, and coarse fragment content. Chemical parameters included pH, electrical conductivity, sodium adsorption ratio, nutrient availability, and acid-base balance. In addition, trace element concentrations were determined for arsenic, boron, copper, lead, manganese, and zinc.

Before this soil is salvaged, shrubs and trees would be cleared to facilitate soil removal. Soil would be salvaged using scrapers, dozers, or front-end loaders as dictated by site conditions. Efforts would be made to minimize compaction. Soil would be handled only when it is dry. Once in the stockpiles, soil would not be disturbed again until it is redistributed.

Approximately 75 percent of the salvaged soils would be placed in stockpiles (figure II-4) for the life of the operation (about 10-11 years). The remaining 25 percent would be hauled directly from newly disturbed areas to graded areas on parts of the waste rock dump. Soil stockpiles would have 2.5:1 (40 percent) sideslopes. When a stockpile reaches design capacity, it would be stabilized with vegetation. The stockpiles would be hydroseeded with the mixture in table II-3 during the first appropriate season after stockpiling. Fertilizer, if necessary, and mulch would be applied.

Before soil is redistributed, compacted areas (for example, the tops of the waste dump and roads) would be ripped to approximately two feet in depth. This would prevent potential slipping at layer contacts and promote root penetration. Soil material would be redistributed in lifts as thick as possible to decrease compaction. To reduce the erosion potential, soils with a higher coarse fragment content would be placed on the steeper sideslopes. On flatter areas, soil materials would be redistributed so that soil containing the least amount of coarse fragments are placed above coarser material. The applicant would sample the respread soils to formulate fertilizer application rates. Post seedling emergence would be observed to monitor soil fertility. If plant nutritional deficiency symptoms appear, micronutrient testing would be included as part of the sampling program and appropriate measures would be taken to correct the problem.

Waste rock would be sampled before soil redistribution to determine potential constraints to revegetation. Parameters to be sampled are texture, coarse fragments content, pH, acid-base balance, plant-available manganese, aluminum, and lead. If unfavorable material is encountered, the dump material would be amended or soil would be applied at a greater depth in this area.

Revegetation: Areas covered with topsoil would be seeded during spring or fall; then mulch and fertilizer would be applied. Specific cultural treatment and seeding methods would depend on slope category. Slopes less than 3:1 would be disced and harrowed, drill-seeded, and crimped with 1 ton per acre of straw mulch. On some steep slopes (over 3:1), seed would be broadcast and mulched at 2 tons per acre. On other steep slopes (dam face, waste rock dump, topsoil stockpiles), seed, fertilizer, and 300-500 pounds per acre of wood-fiber mulch would be applied in slurry form (hydroseeding). After the initial application, 1,500-1,700 pounds/acre of tackifier-containing mulch would be sprayed over the slopes.

Tree and shrub seedlings would be planted on the waste rock dump and on the facilities site. To increase seedling survival, several measures are proposed to reduce competition from herbaceous plants. On dump tops, 12 sites per acre would not be seeded. Twenty-five seedlings would be planted on each of these 50-foot-diameter, circular sites. Competition on dump slopes would be reduced by scalping, applying herbicides or soil sterilants, using various mulches, or reducing the seeding rate. Scalping would lower competition on the dump's sediment-control structures.

The applicant proposes to establish 420 acres of grassland, 355 acres of Douglas-fir forest, 183 acres of shrub/grassland, and 7 acres of aspen forest. The grassland seed mixture (table II-7) would be used on the tailings dump, the waste rock dump tops, road and tailings line corridors, and part of the facilities site. The remainder of the facilities site would be seeded with the shrub/grassland mixture (table II-7) as would the dam face and portions of the waste rock dump slopes. The Douglas-fir seed mixture (table II-8) would be spread over the north slopes of the waste rock dump and the pit. The pit, however, would have steep slopes alternating with the benches, no topsoil, and increasing water levels. A narrow strip of the waste rock dump would receive the aspen seed mixture (table II-8). Tree or shrub seedlings would be planted at various rates in all but the grassland revegetation type (table II-9).

Table II-7: Grassland and Shrub/Grassland Seed Mixtures

	Grassland Mixture		Shrub/grassland Mixture	
Common Name[1]	Rate[2] (pure live seed)	Percent of mixture[3]	Rate[2] (pure live seed)	Percent of mixture[3]
Idaho fescue[4]	1.0 lbs/acre	9.9	1.0 lbs/acre	9.1
Rough fescue[5]	2.0 lbs/acre	8.9	2.0 lbs/acre	8.2
Bluebunch wheatgrass[6]	4.0 lbs/acre	12.9	4.0 lbs/acre	11.8
Kentucky bluegrass	0.25 lbs/acre	11.9	0.25 lbs/acre	10.9
Canada bluegrass	0.25 lbs/acre	13.9	0.25 lbs/acre	12.7
Slender wheatgrass	4.0 lbs/acre	11.9	4.0 lbs/acre	10.9
Mountain brome	5.0 lbs/acre	9.9	5.0 lbs/acre	9.1
Sulfur buckwheat	1.0 lbs/acre	4.9	1.0 lbs/acre	4.5
Common yarrow	0.1 lbs/acre	5.9	0.1 lbs/acre	5.5
Arrowleaf balsamroot	2.0 lbs/acre	3.0	2.0 lbs/acre	2.7
Missouri goldenrod	0.1 lbs/acre	3.0	0.1 lbs/acre	2.7
Clover	0.25 lbs/acre	4.0	0.25 lbs/acre	3.6
Antelope bitterbrush	0.0 lbs/acre	0.0	3.0 lbs/acre	0.9
Wood's rose	0.0 lbs/acre	0.0	1.0 lbs/acre	0.9
Green rabbitbrush	0.0 lbs/acre	0.0	0.5 lbs/acre	6.4
TOTALS	20.0 lbs/acre	100	24.5 lbs/acre	100

Source: Project application, 1984.

[1] See Appendix 5 for scientific names.

[2] Drill-seeding rate; broadcast rates would be twice as high. Total is rounded to the nearest 0.1 pound.

[3] Based on number of pure live seeds per square foot. Total percentage rounded to 100.

[4] Sheep fescue would be used if Idaho fescue is unavailable.

[5] Tall fescue would be used if rough fescue is unavailable.

[6] Beardless wheatgrass would be used if bluebunch wheatgrass is unavailable.

Monitoring and Management: The applicant would establish small test plots on the waste rock dump and the tailings dump. Revegetation methods would be evaluated on these test plots. Based on the results, the applicant may choose to modify revegetation procedures; DSL approval would be required for all modifications. Livestock grazing would not be permitted for 2 years after seeding. Where necessary, the applicant would attempt to control wildlife damage with fences, chemical repellents, or terminal bud coverings.

Surface water resources would be monitored for flow and water quality during the life of the project. Results of operational water monitoring could be used to determine whether water quality has changed and project design objectives have been met.

Table II-8: Douglas-fir and Aspen Seed Mixtures

	Douglas-fir mixture		Aspen mixture	
Common name[1]	Rate (pure live seed)[2]	Percent of mixture[3]	Rate (pure live seed)[2]	Percent of mixture[3]
Idaho fescue[4]	1.0 lbs/acre	9.4	0.0 lbs/acre	0.0
Rough fescue[5]	2.0 lbs/acre	8.5	0.0 lbs/acre	0.0
Bluebunch wheatgrass[6]	4.0 lbs/acre	12.3	0.0 lbs/acre	0.0
Kentucky bluegrass	0.25 lbs/acre	11.3	0.25 lbs/acre	11.3
Canada bluegrass	0.25 lbs/acre	13.2	0.25 lbs/acre	13.2
Slender wheatgrass	4.0 lbs/acre	11.3	4.0 lbs/acre	11.3
Mountain brome	5.0 lbs/acre	9.4	5.0 lbs/acre	9.4
Tufted hairgrass	0.0 lbs/acre	0.0	0.25 lbs/acre	13.2
Colonial bentgrass	0.0 lbs/acre	0.0	0.1 lbs/acre	15.1
Common yarrow	0.1 lbs/acre	5.7	0.1 lbs/acre	5.7
Arrowleaf balsamroot	3.0 lbs/acre	3.8	0.0 lbs/acre	0.0
Missouri goldenrod	0.1 lbs/acre	2.9	0.0 lbs/acre	0.0
Clover	0.5 lbs/acre	7.5	0.5 lbs/acre	7.5
Sticky geranium	0.0 lbs/acre	0.0	2.0 lbs/acre	1.9
Antelope bitterbrush	2.0 lbs/acre	0.9	0.0 lbs/acre	0.0
Wood's rose	1.0 lbs/acre	0.9	1.0 lbs/acre	0.9
Serviceberry	0.5 lbs/acre	0.9	1.0 lbs/acre	0.9
Snowberry	0.0 lbs/acre	0.0	0.5 lbs/acre	0.9
Oregon grape	0.0 lbs/acre	0.0	1.0 lbs/acre	0.9
Aspen	0.0 lbs/acre	0.0	0.1 lbs/acre	7.5
Lodgepole pine	0.5 lbs/acre	0.9	0.0 lbs/acre	0.0
Douglas-fir	1.0 lbs/acre	0.9	0.0 lbs/acre	0.0
TOTALS	25.2 lbs/acre	100	16.1 lbs/acre	100

Source: Project application, 1984.

[1] See Appendix 5 for scientific names.

[2] Drill-seeding rate; broadcast rate would be twice as high. Total is rounded to nearest 0.1 pound.

[3] Based on number of pure live seeds per square foot. Total percentage rounded to 100.

[4] Sheep fescue would be used if Idaho fescue is unavailable.

[5] Tall fescue would be used if rough fescue is unavailable.

[6] Beardless wheatgrass would be used if bluebunch wheatgrass is unavailable.

Ground water levels and water quality data would be monitored at selected stations in the area of the pit, down-gradient from the tailings disposal area, and down-gradient from the waste rock dump.

Final design of both operational and, if necessary, post-mining water monitoring programs would be approved by DSL before project construction begins.

Table II-9: Tree and Shrub Planting Locations and Rates

Disturbance area	Revegetation type	Species	No. of containerized seedlings per acre[1]
Waste-rock dump tops[2]	Grassland (420 acres)	Douglas-fir[3]	444
		Lodgepole pine	111
		Total trees/acre	555
Waste-rock dump slopes (north-facing only)	Douglas-fir (193 acres)	Douglas-fir	240
		Lodgepole pine	60
		Total trees/acre	300
		Antelope bitterbrush	120
		Wood's rose	40
		Serviceberry	40
		Total shrubs/acre	200
Waste-rock dump slopes	Shrub/grassland (183 acres)	Antelope bitterbrush	225
		Wood's rose	45
		Green rabbitbrush	30
		Total shrubs/acre	300
Waste-rock dump sediment control structure	Aspen (7 acres)	Aspen	100
		Total trees/acre	100
		Oregon grape	30
		Wood's rose	150
		Serviceberry	30
		Red raspberry	60
		Snowberry	30
		Total shrubs/acre	300

Source: Project application, 1984.

[1] If bare-root seedlings are used, the rate would be doubled.

[2] Trees would be planted in 50-foot diameter sites (12 sites per acre).

[3] See Appendix 5 for scientific names.

Alternative 2 (Proposal with Mitigating Measures)

The mining and reclamation plan in this alternative would be the same as the proposal (Alternative 1) except that a series of mitigating measures--methods to reduce expected impacts of the proposal (see Chapter IV)--are assumed part of the plan.

Mitigating measures considered in the analysis of this alternative would require the following of the applicant.

Measure A

The applicant would design the process-water retention pond with sufficient storage capacity to operate during extreme drought conditions, or would purchase downstream senior water rights.

During low-flow periods, this mitigation would protect water users downstream who have water rights pre-dating those of the applicant.

Measure B

The applicant would divert Spring Creek surface water below Corbin rather than pump ground water supplies upstream of Corbin.

This mitigation would protect the Spring Creek fishery and Corbin water supply from the effects of dewatering.

Measure C

The applicant would line the process-water retention pond with an 80-mil, high-density, polyethylene liner.

This mitigation would reduce seepage through the retention pond by about three orders of magnitude and would decrease the potential for water quality impacts.

The proposed recovery well/pump back system would not be required unless operational ground water quality monitoring indicated significant contamination originating in the tailings disposal area.

Measure D

The applicant would cap the surface of the tailings before soil redistribution with at least 12 inches of innocuous waste rock (that is, waste rock other than sub-ore grade diatreme). Other methods of preventing soil contamination from the tailings would be acceptable if adequately demonstrated to DSL.

This mitigation would help to prevent acidification and trace-element contamination that could occur due to the acid-producing characteristics of the tailings.

Measure E

The applicant would direct runoff water in final reclamation from Pen Yan Creek toward Wood Chute Creek, rather than toward the small but steep unnamed ephemeral draw. A small modification in the shape of the waste rock dump would allow Pen Yan Creek to be diverted to the south along the western margin of the dump (toward Wood Chute Creek).

This mitigation would prevent channel erosion in the small unnamed tributary caused by diverting both Homestake and Pen Yan creeks to a single drainage.

Measure F

The applicant would take necessary measures to insure reforested areas contain a density of conifers comparable to the density existing in the premining coniferous forests.

This mitigating measure would improve postmining wildlife habitat by providing cover quality similar to that existing before mining.

Measure G

The applicant would establish a density of shrubs in the reclaimed shrub/grasslands that will provide adequate mule deer habitat.

This mitigating measure would insure forage supply for mule deer.

Measure H

The applicant would submit a wildlife monitoring management plan for department approval before mine development activities begin. The plan would address:

1) monitoring the tailings disposal facility for deer and elk use and, if use occurs, the measures the applicant would take to prevent deer and elk use of the facility,
2) managing blasting to reduce wildlife disturbance,
3) educating employees to reduce wildlife harassment,
4) implementing policies to discourage violation of game laws, and
5) handling attractants to prevent problems with bears or other wildlife.

This mitigation would reduce potential impacts of the project on wildlife.

Measure I

Implement measures aimed at reducing traffic through Jefferson City such that total round trips to and from the mine are no more than one-third of the work force.

This mitigation would reduce the traffic hazard and inconveniences caused by routing mine traffic through Jefferson City. Measures that the applicant could consider include providing a bus or shuttle service or providing incentives for employee carpools.

Alternative 3 (Modification of the Mine Plan)

Plant Site Option

The only change in the applicant's proposed production system arrangement is an alternate site plan for location of the ore processing plant. The alternate site is within the proposed permit boundary on the south edge of hay and pasture land, northeast of the proposed plant site (figure II-8). For economic reasons, the applicant may build the plant at this alternate location. Site preparation and construction would require less excavation and time. The alternate plant site would require construction of a conveyor about 1/2 mile in length between the crusher and coarse ore stockpile.

Alternative 3 would incorporate the mitigating measures described under alternative 2.

Other Options

Other arrangements--that is, changes in the mining method, tailings disposal methods, tailings and waste rock disposal locations, and mine-access roads--were studied. In each case, the changes provided no environmental advantages or were economically or technically unfeasible. The arrangements considered include:

Mining Method: The open pit could be avoided by mining the ore body underground. Underground mining methods, however, are both technically and economically unfeasible. The soft ore and disseminated mineralization would make underground mining unsafe and ore recovery inefficient. Costs for underground mining are greater than open pit mining by a factor of 10 or more. These conditions would make ore extractions by underground methods unfeasible at today's metal prices.

Tailings Disposal Methods: Conventional tailings disposal methods or dry-filtered tailings disposal systems would either be environmentally inferior or would offer no advantages to the applicant's proposed disposal system.

Conventional tailings disposal would require either an earth-filled or cycloned sand dam to contain the tailings. A slurry cutoff wall and grout curtain in weathered bedrock or a pond liner would be needed to control seepage from the impoundment. Seepage rates, however, would be the same or greater than the proposed disposal system. In addition, a conventional disposal system would impound saturated tailings. Thus, stability of the dam would be lower than that of the proposed system.

A dry-filtered tailings disposal system would use belt filters or cyclone separators to remove the water from the tailings. The filtered tailings would then be transferred by conveyor to a dump. Tailings would contain 15 to 20 percent moisture. Seepage from the tailings would be controlled in a fashion similar to the proposal. A seepage collection pond downstream of the tailings

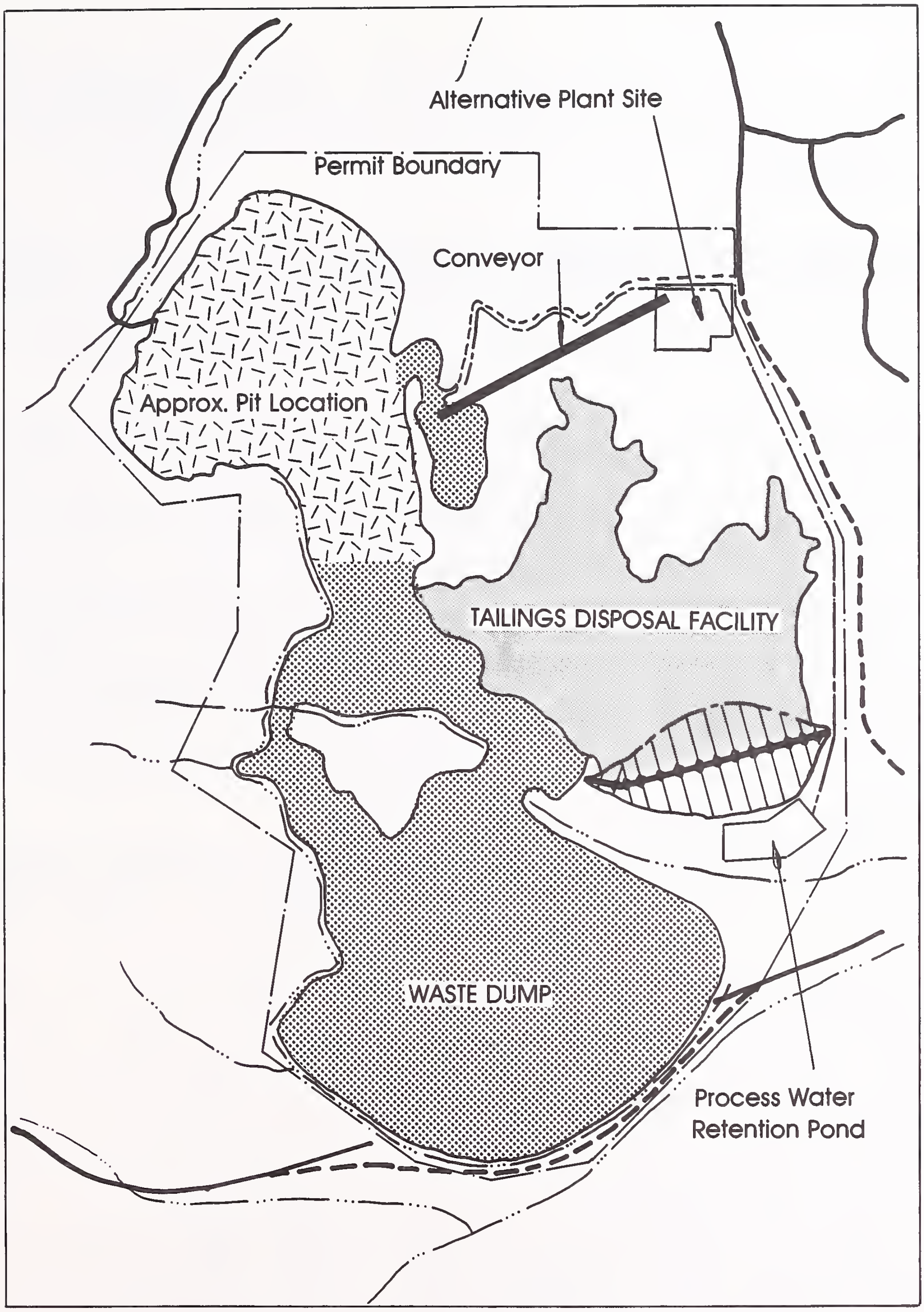


Figure II-8

Alternative 3 differs from alternative 2 only in the placement of the project's plant site. The alternate plant site would require less site preparation compared to the applicant's proposal.

pile would be built to collect seepage water. Essentially, this system differs from the proposal only in that it uses a mechanized method of removing the residual water from the tailings rather than a system relying on gravity drainage and evaporation. The option provides no advantages to the proposed disposal system.

Tailings Disposal Locations: An evaluation of alternate disposal sites was not warranted because no objectionable hydrologic or geologic characteristics of the disposal site were found that would preclude the design objectives of the disposal system. In addition, mitigating measures under alternative 2 would reduce potential environmental impacts of the proposed disposal system.

Waste Rock Dumps: There are no alternate dump sites that would offer an environmental advantage to the proposal (for example to reduce visual impact). A site northeast of the pit in a saddle-like depression has a capacity for 30 percent of the waste rock. This alternate dump site would only reduce the southerly extension of the proposed dump. Visual impacts would be the same or greater with the alternate dump site.

Road Access: The Clancy Creek Road would provide an existing alternate road access to the mine. The road is less direct than the proposed road, would continue to route traffic through a residential area, and would require extensive road improvements. The option provides no advantages to the proposed access.

Alternative 4 (No Action)

Under this alternative, the applicant would not develop the Montana Tunnels project.

Chapter III:
The Existing Environment

GEOLOGY

Mining History

The Montana Tunnels project area is in the historic Corbin-Wickes mining district (figure III-1). This district boomed before 1900, producing over $40 million from gold, silver, and lead ores (Becraft et al., 1963). At least 11 mines, 7 concentrating mills, and 3 smelter refineries operated at various times.

The largest mine in the district was the Alta, an underground silver mine that generated over $32 million in revenues before 1892 (Chadwick, 1982). Underground operations at the Alta ceased in 1896 due to declining silver grades, increased production costs, and falling metal prices.

From 1950 to 1956, low-grade silver ore was mined from an open pit atop Alta Mountain. This ore was shipped to East Helena and used as silica flux in the ASARCO smelter. The Alta workings are located due east of and less than two miles from the Montana Tunnels proposed mine pit area.

Three other underground mines--the Gregory, Minah, and Washington--were also primary producers in the district. The Gregory Mine, located in the Clancy Creek drainage, is about 1-1/2 miles northeast of the project area. The Minah and Washington mine workings are within or immediately adjacent to the proposed project area. A worldwide silver panic caused by the overproduction of silver coupled with ill-conceived U.S. government subsidies closed all but the highest-grade mines in the district after 1893 (Chadwick, 1982).

The Corbin Copper Company, sparked by the sudden copper boom in 1900, opened two closely spaced tunnels (adits) on the Montana claim (hence the name Montana Tunnels), plus numerous pits, trenches, and short adits on other claims in the immediate vicinity between 1900 and 1910. No significant production was ever recorded. The dump material contains galena (lead sulfide), sphalerite (zinc sulfide), chalcopyrite (copper-iron sulfide), and pyrite (iron sulfide).

Topography and Geomorphology

The Montana Tunnels project area is in the northern part of the Boulder Mountains, a mountainous region of moderate relief stretching south of Helena

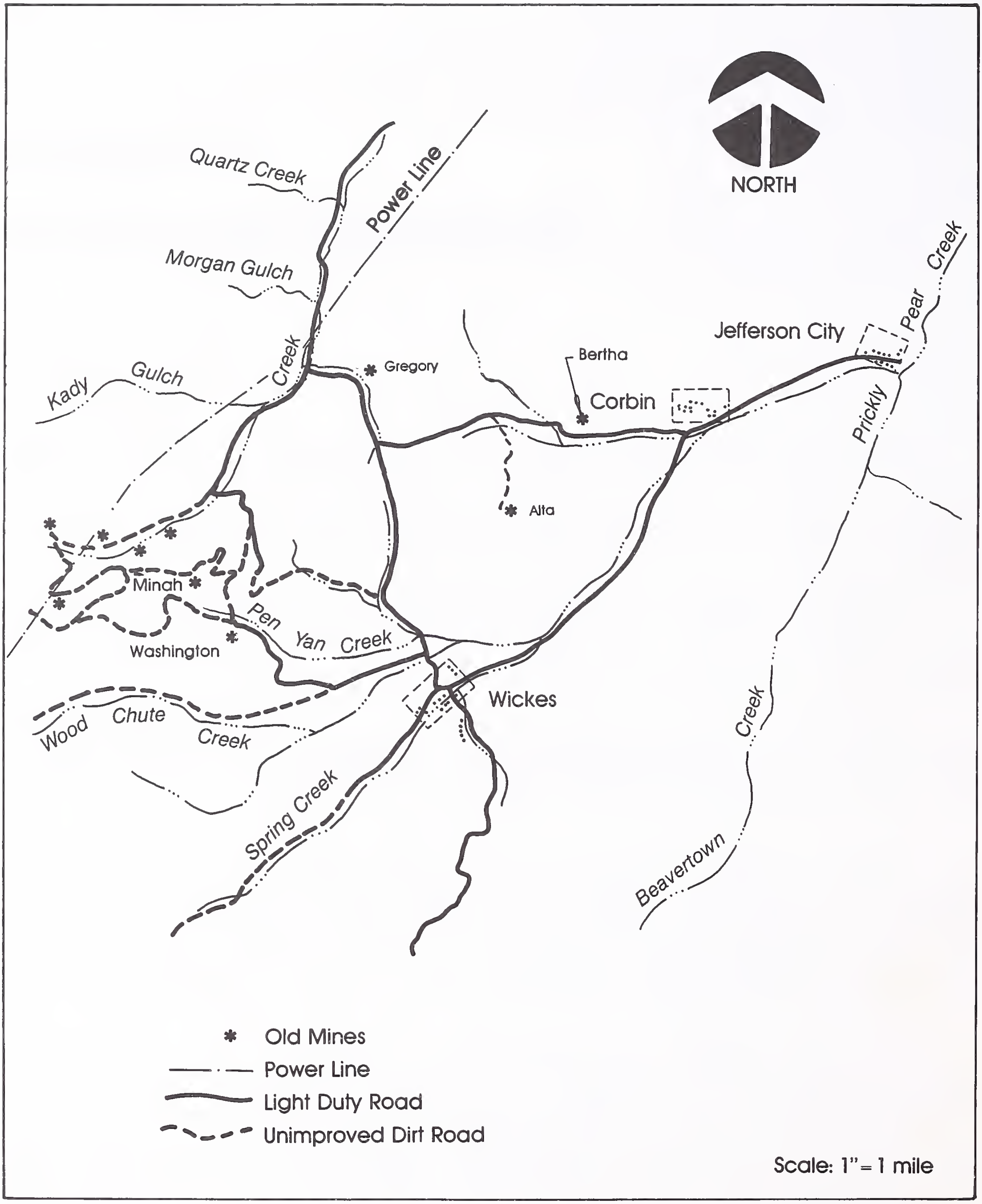


Figure III-1

The location of the more important historic mines in the Corbin-Wickes mining district, as well as drainages, gravel roads, and power lines, are depicted on this map.

to Butte. The project area is located on the eastern flanks of the Boulder Mountains at elevations of 5,300 to 6,300 feet. The Prickly Pear valley separates the Boulder Mountains and the geologically related Elkhorn Mountains to the east. The Occidental Plateau to the west of the project area is a broad wind-swept ridge exceeding 7,600 feet.

The Montana Tunnels project area covers two intermediate-sized stream drainages, both tributaries to Prickly Pear Creek. The extreme northwestern corner of the project area drains to the northwest into Clancy Creek. The remainder of the project area is located in three ephemeral tributaries of Spring Creek--Homestake, Pen Yan, and Wood Chute creeks (see figure III-1).

The mineralized ore zone occupies a small saddle between Clancy and Homestake creeks. The crest of the saddle is about 5,830 feet. The Clancy Creek valley bottom is about 200 feet lower and the lowest point in Homestake Creek is about 600 feet lower.

The proposed tailings impoundment area would occupy the Homestake Creek drainage in a moderate to gentle valley bottom below 5,500 feet. The proposed waste disposal area would occupy the lower half of Pen Yan Creek and part of a gentle glacial outwash terrace of Wood Chute Creek. A small steep-sided ridge separates Homestake and Pen Yan creeks in the middle of the project area.

Most of the precipitation in the project area is lost to evaporation or infiltrates the ground, so that little surface runoff normally occurs. Active channels in the valley bottoms are small or non-existent. There is also little evidence of excessive hillslope or channel-bottom erosion on the site.

Geologic History

The project area is dominated by volcanic ash deposits of two different ages. The older Elkhorn volcanics were deposited about 78 to 68 million years ago. The younger ash deposits, collectively called the Lowland Creek volcanics, were deposited on top of the Elkhorn volcanics about 50 to 48 million years ago. Erosion since that time removed most of these volcanic ash deposits from the Boulder Mountains, exposing the underlying Boulder Batholith granitic rock. A 28-square-mile patch of Elkhorn volcanics and an even smaller patch (less than 5 square miles) of Lowland Creek volcanics is all that remains of the volcanics in the Corbin-Wickes area (see appendix figure A-1).

Mine Pit Area: The proposed project area is in the center of an ancient volcanic vent called a diatreme (see figure III-2). This vent was probably one of several centers of volcanic eruptions which formed the Lowland Creek volcanics. The diatreme is comprised of Lowland Creek feldspar-rich ash and fragment inclusions of older (underlying) Boulder Batholith and Elkhorn volcanic rocks. Also preserved in the diatreme are large coherent blocks of Lowland Creek and Elkhorn volcanics which fell into the volcanic vent, especially along the northern and southern extensions.

At least three east- to northeast-trending tabular intrusions (quartz-latite porphyry dikes) cut across the diatreme. The two largest are up to 300 feet wide and dip toward each other at 60 to 85 degrees (see figure III-3).

The gold-silver mineralized zone occupies about 10 percent of the diatremes' surface area, between the two largest latite-dike intrusions (see figure III-2). The mineralized zone is truncated on the north by an east-west-trending fault. The ore grade drops off in all other surface directions, but mineable grades of ore continue downward within the diatreme (plunging to the southwest). The gold-silver mineralization was a result of hot-water solutions upwelling in the central core of the diatreme. These waters dissolved and altered the feldspar-rich diatreme rocks. The result was a precious metal-rich core of weaker rock within the diatreme vent.

The ore body has a gold-to-silver ratio of 1:10. Gold and silver mineralization in this ore body is generally associated with sulfide minerals disseminated throughout the mineralized core of the diatreme. Sulfide comprises 3 to 15 percent of the mineralized ore rock by volume. The metallic mineralization consists chiefly of pyrite (iron sulfide), sphalerite, and galena, with minor amounts of chalcopyrite and traces of copper and silver sulfides. Gold mineralization in this ore body is always in combination with silver in what is called a gold-silver electrum. Only 10 percent of the silver in the ore body is associated with gold. The remaining 90 percent is associated with lead sulfide (galena) in a solid solution series. Very little of the gold or silver occurs as free, pure metallic minerals (project application, 1984).

Only the very top of the ore zone is oxidized. Iron oxides and sulfides are the main oxidation products. Cadmium levels in the ore zone are highest at the top of the ore body and drop off with increasing depth.

Remainder of Project Area: The upland areas of the remainder of the project area are underlain by either Lowland Creek or Elkhorn volcanic bedrock which dip moderately to the south and east. The valley bottoms of Pen Yan and Homestake creeks have stream-laid (alluvial) deposits approaching 100 feet thick. The alluvial deposits of Homestake Creek near the axis of the proposed tailings dam consist of two general groups: an upper zone of scattered, coarser channel deposits (gravels and cobbles) within finer-grained overbank deposits. The lower zone is more uniformly coarse textured and consists of gravels and cobbles in a finer-grained matrix.

A layer of coarse slope-wash material (colluvium) mantles most of the upland hillslopes. The colluvium is shallow to about 40 feet thick and generally contains a substantial amount of coarse rock fragments. The underlying volcanic bedrock is weathered and fractured to a depth of 100 feet in some places.

The wide valley bottom of Wood Chute Creek has what is interpreted as glacial melt-water outwash deposits (sands and gravels) to a depth of 65 feet. Below this is an alluvial sequence similar to that described for Homestake Creek.

One backhoe test pit dug along the northeastern edge of the proposed waste dump encountered a 6- to 12-inch-thick bentonite clay layer at 4 to 6 feet. The bentonite layer, apparently localized because it was not encountered in other test pits, was probably volcanic ash that altered to bentonite clays.

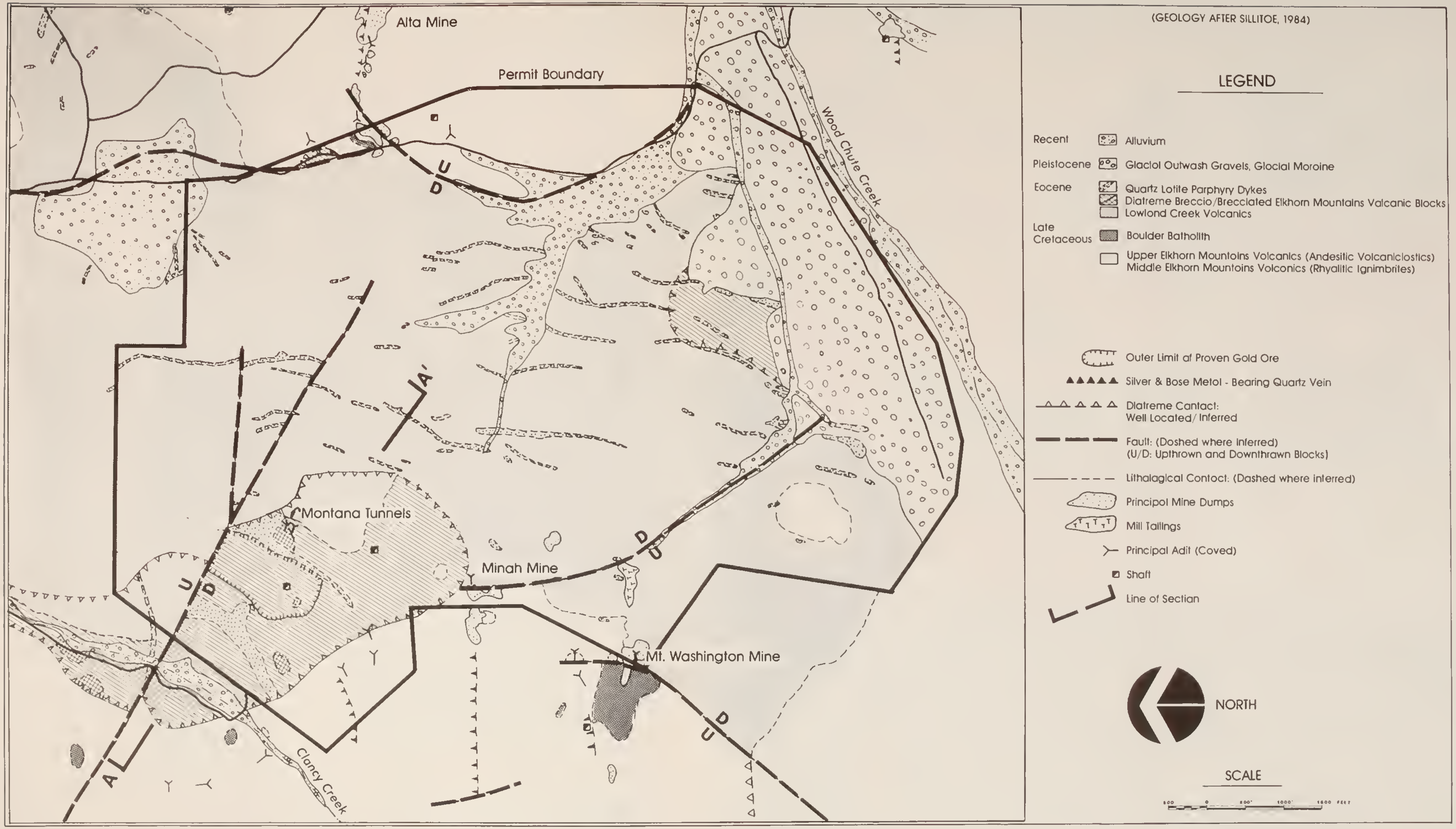

Alta Mine
Permit Boundary
Wood Chute Creek
U
D
A'
Montana Tunnels
Minah Mine
D
U
Mt. Washington Mine
D
U
U
D
Clancy Creek
A
(GEOLOGY AFTER SILLITOE, 1984)
LEGEND
Recent
Alluvium
Pleistocene
Glacial Outwash Gravels, Glacial Moraine
Eocene
Quartz Latite Porphyry Dykes
Diatreme Breccia/Brecciated Elkhorn Mountains Volcanic Blocks
Lowland Creek Volcanics
Late Cretaceous
Boulder Batholith
Upper Elkhorn Mountains Volcanics (Andesitic Volcaniclastics)
Middle Elkhorn Mountains Volcanics (Rhyolitic Ignimbrites)
Outer Limit of Proven Gold Ore
Silver & Base Metal - Bearing Quartz Vein
Diatreme Contact: Well Located/ Inferred
Fault: (Dashed where inferred) (U/D: Upthrown and Downthrown Blocks)
Lithological Contact: (Dashed where inferred)
Principal Mine Dumps
Mill Tailings
Principal Adit (Caved)
Shaft
Line of Section
NORTH
SCALE

Figure III-2
This map shows the surface geology of the project area. The line of section through the proposed mine pit area (depicted in Figure III-3) is indicated as A-A'.

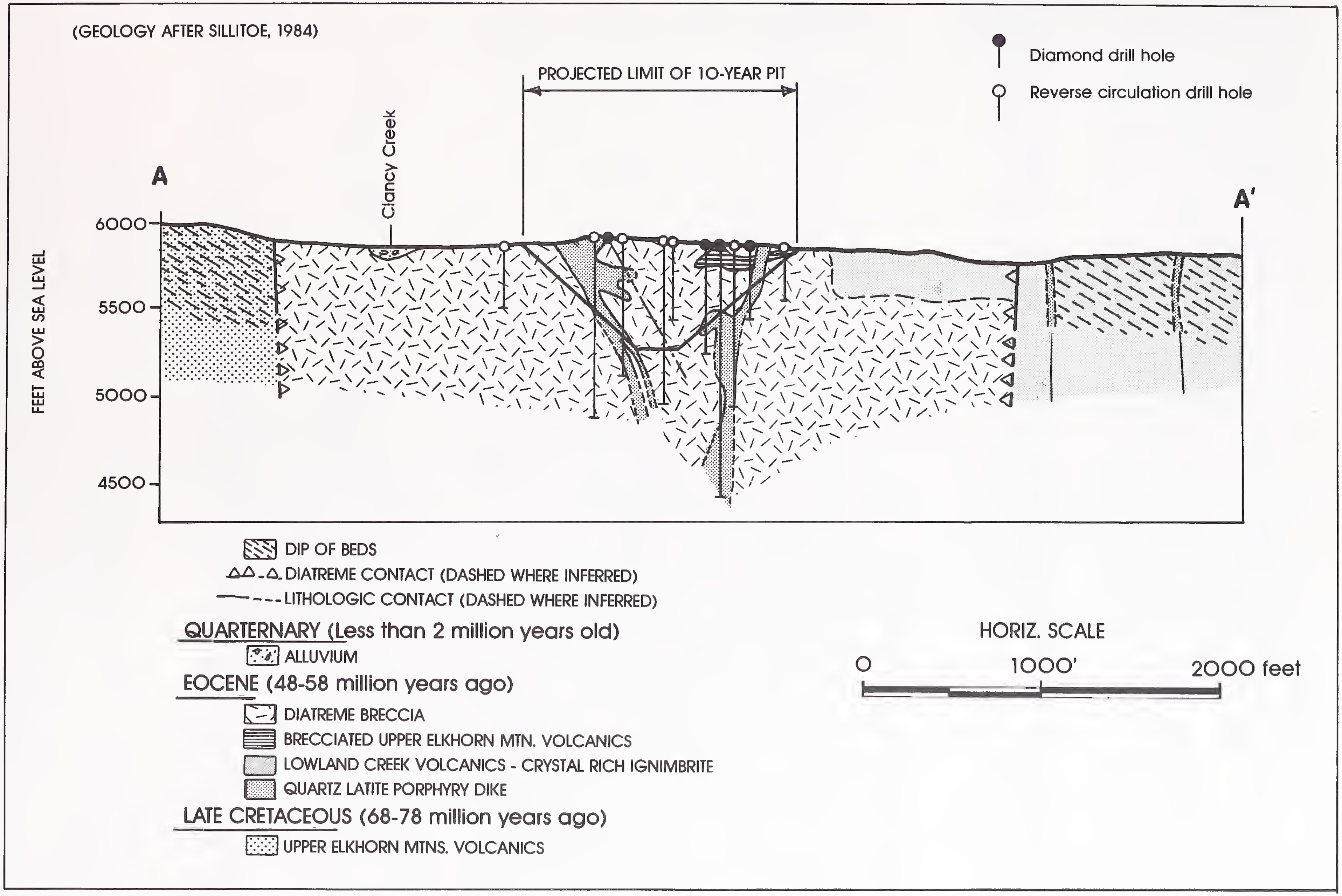

(GEOLOGY AFTER SILLITOE, 1984)
Diamond drill hole
Reverse circulation drill hole
PROJECTED LIMIT OF 10-YEAR PIT
Clancy Creek
A
A'
FEET ABOVE SEA LEVEL
6000
5500
5000
4500
DIP OF BEDS
DIATREME CONTACT (DASHED WHERE INFERRED)
LITHOLOGIC CONTACT (DASHED WHERE INFERRED)
QUARTERNARY (Less than 2 million years old)
ALLUVIUM
EOCENE (48-58 million years ago)
DIATREME BRECCIA
BRECCIATED UPPER ELKHORN MTN. VOLCANICS
LOWLAND CREEK VOLCANICS - CRYSTAL RICH IGNIMBRITE
QUARTZ LATITE PORPHYRY DIKE
LATE CRETACEOUS (68-78 million years ago)
UPPER ELKHORN MTNS. VOLCANICS
HORIZ. SCALE
0
1000'
2000 feet

Figure III-3

This geology cross-section of the mine pit areas shows the diatreme breccia and the surrounding bedrock. The applicant expects to excavate gold, silver, lead, and zinc ore from the central core of the diatreme.

The eastern abutment of the proposed tailings dam is composed of highly weathered and hydrothermally altered Elkhorn volcanic rocks. The central area has alluvial valley fill deposits up to 100 feet thick overlying Lowland Creek ash deposits. A fault along the eastern edge of the Homestake valley downdropped the western side, preserving the younger Lowland Creek volcanics. The volcanics are weathered to at least 70 feet below the alluvium. The western abutment is composed of weathered Lowland Creek volcanics. Joints at depth reduce the rock strength somewhat below 66 feet at the western abutment.

The project area is criss-crossed by a series of east-west faults as well as a north-south system of larger, graben-type faults. These faults date back as far as 50 million years and may have been active before and after emplacement of the diatreme. They do not appear to have been active during recent times.

Earthquakes and Recent Faulting

Recent movement along faults within the project area has not been documented. Faults most likely to be the source of strong groundshaking at the site are in the Helena and Townsend valleys (Stickeny and Bingler, 1981). Both valleys are part of distinct zones of higher earthquake activity--extending from Salt Lake City through Yellowstone Park, the Townsend valley/Helena area, and terminating near Kalispell--called the Intermountain Seismic Belt (Qamar and Stickeny, 1983). The Helena area is moderately active; an earthquake greater than magnitude 6 is expected on the average of every 70 years. A magnitude of 7 is expected about every 360 to 470 years (project application, 1984). The strongest earthquakes to strike the Helena area during the last 100 years occurred in 1935. The first and largest quake measured 6.25 on the Richter scale and was followed two weeks later by a magnitude 6.0 event. Over 2,000 quakes were recorded over the following year. The two large quakes caused property damage in excess of $2 million in Helena. Peak horizontal ground acceleration during the later quake measured only about 10 percent of gravity but was large enough to cause further damage and loss of two lives.

The Helena valley is bound along the north side by a long, continuous fault exhibiting renewed, recent movement. Another fault may exist under the valley trending southeasterly from the Scratch Gravel Hills through East Helena. It was this later fault, called the Prickly Pear Fault, that is believed to have caused the 1935 quake (see Appendix I).

The project area is about 20 miles south of the nearest known fault, the Prickly Pear fault. Because the earthquake energy drops off rapidly with increasing distance, groundshaking at the site could be three or more times less than experienced in Helena (Bolt and Abrahamson, 1983).

HYDROLOGY

Surface Water

The proposed mine, mill, and tailings areas are drained by tributaries of Spring Creek including Homestake Creek, Pen Yan Creek, and Wood Chute Creek. A portion of the proposed open pit is contained in the Clancy Creek drainage.

Spring Creek and Clancy Creek are perennial streams that flow northeastward where they eventually join Prickly Pear Creek (see figure III-4).

Watersheds consist of both forested and open grassland mountain slopes. Stream channel gradients generally are steep in the upper reaches with flatter slopes in the larger valley areas downstream. Streamflow is derived primarily from snowmelt in the spring and early summer as well as from intense rainfall events. Bedrock discharge from springs provides base flow to perennial streams.

Hydrologic characteristics of watersheds in the proposed project area are provided in table III-1 and are discussed below. Water resources data collected at the project site during water year 1985 are indicative of prevailing drought conditions and therefore do not portray average runoff events.

Clancy Creek: Numerous springs in the headwaters of Clancy Creek sustain streamflow in the vicinity of and downstream of the proposed mine area throughout the year. Streamflow fluctuates seasonally with peak flows generally occurring during early June. The stream reach adjacent to the proposed open pit appears to receive some recharge from saturated alluvium and fractured bedrock. Below the confluence of Quartz Creek, Clancy Creek apparently loses a significant amount of flow to channel infiltration.

Spring Creek: Spring Creek contains numerous springs that generally seep back into the ground water system a short distance downstream from their source. The long-term mean annual flow of Spring Creek was estimated to be about 2.9 cubic feet per second (project application, 1984). Flow is maintained at a relatively constant rate from springs in the southwest quarter of section 11, township 7 north, range 4 west.

Homestake Creek: During the study period, Homestake Creek was perennial to a point where it infiltrates the alluvium in section 16, township 7 north, range 4 west. The estimated long-term mean flow is about 0.2 cubic feet per second. Peak flow for the period of measurement was about 0.05 cubic feet per second. The proposed pit, tailings dump, and waste rock piles are located in areas drained by Homestake Creek.

Pen Yan Creek: Pen Yan Creek is perennial from the Washington Mine discharge to its confluence with Homestake Creek. Apparently, flow is maintained over a perched zone of less-permeable, fine-grained mill tailings. The long-term mean flow is estimated to be 0.4 cubic feet per second. Maximum flow during the study period was about 0.22 cubic feet per second.

Wood Chute Creek: The long-term mean flow of Wood Chute Creek is estimated to be 0.9 cubic feet per second. Wood Chute Creek was dry during the baseline period of measurement.

Prickly Pear Creek: The USGS compiles stream-flow data from station number 06061500 about 1 mile upstream from Montana City. Average monthly flows range from 21 cubic feet per second in January to about 138 cubic feet per second in June. Further upstream, where Spring Creek enters Prickly Pear Creek, the drainage area is much smaller. Average monthly flows in Prickly Pear Creek are estimated to range between 5.8 cubic feet per second in January

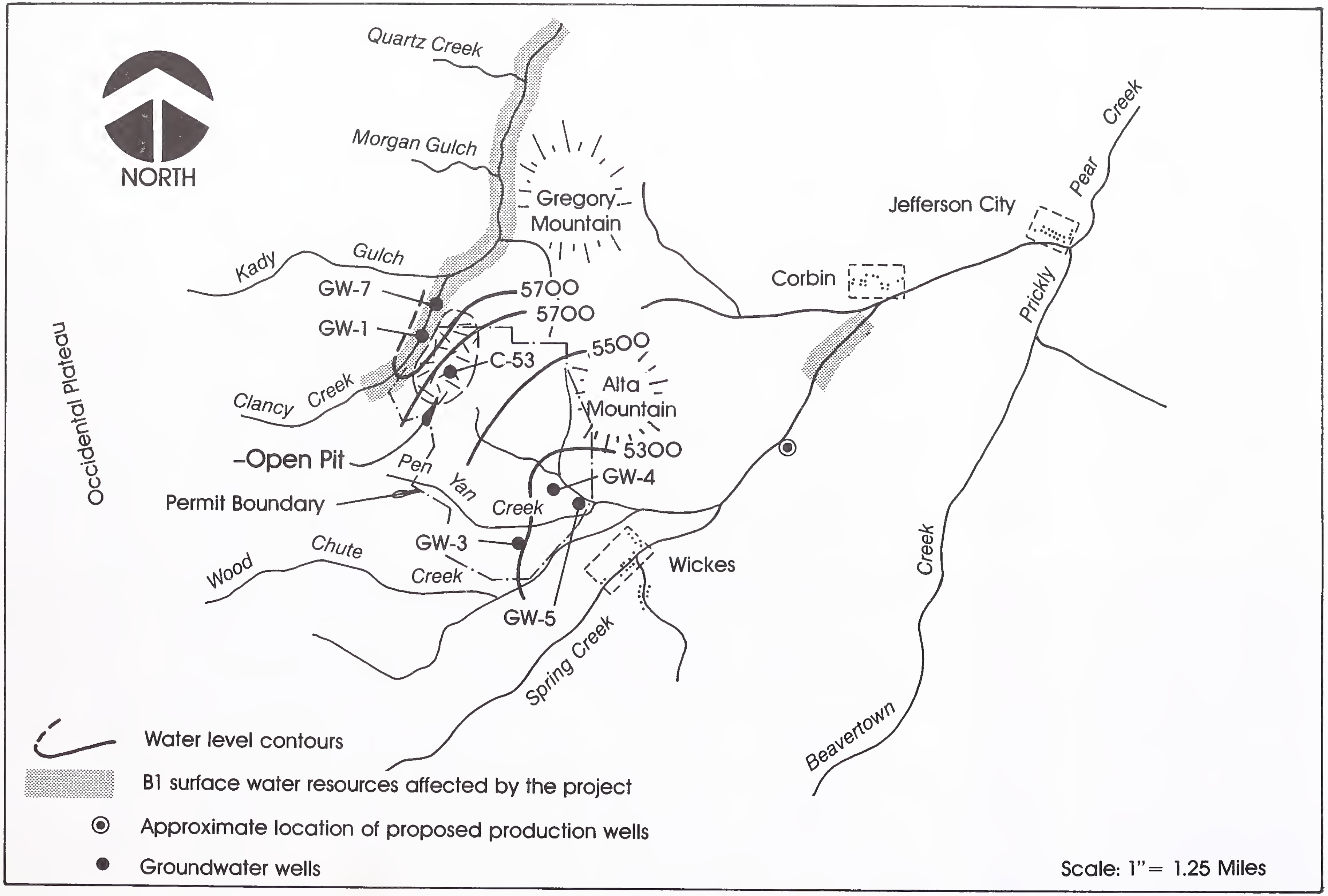


Figure III-4

Surface water flows north-northeast toward East Helena. Ground water flows east from the tailings disposal area toward Spring Creek.

Table III-1: Hydrologic Characteristics at Selected Monitoring Stations in the Proposed Project Area

	Clancy Creek[1]	Spring Creek[2]	Homestake Creek	Pen Yan Creek	Wood Chute Creek
Drainage area (square miles)	1.4	22.0	2.0	1.1	5.2
Maximum recorded flow in 1985 (cfs)	1.4	2.7	0.05	0.22	dry
Estimated long-term average annual flow (cfs)	2.1	2.9	0.2	0.4	0.9
Estimated magnitude of flood events					
2-year flood	7.3	--	9.3	5.9	23.1
5-year flood	15.5	--	32.0	15.9	50.0
10-year flood	22.4	--	60.0	25.9	73.0
100-year flood	53.0	--	276.0	85.0	173.0
Surface water quality[3] (mg/l)					
pH	6.6-7.4	6.6-7.5	7.3-7.9	7.1-7.5	dry
Total dissolved solids	107-195	157-306	378-437	438-614	dry
Sulfate	34-53	107-133	182-208	240-390	dry
Arsenic	<0.005-0.015	0.007-0.069	0.034-0.075	0.01-0.123	dry
Cadmium	<0.001-0.003	<0.001-0.003	0.004	0.011-0.038	dry
Iron	0.10-0.13	<0.05	<0.03-0.24	<0.03-0.28	dry
Lead	<0.01	<0.01-0.02	<0.01-0.03	<0.01-0.03	dry
Manganese	0.10-0.37	0.02-0.04	<0.02-0.18	2.79-4.08	dry
Zinc	0.03-0.06	0.05-0.16	0.11-0.24	3.76-7.13	dry
Cyanide	<0.01	<0.01	<0.01	--	dry

Source: Project application, 1984.

[1] Drainage area above proposed open pit.

[2] Spring Creek above Corbin.

[3] Range of concentrations for period of measurement. Metals concentrations represent dissolved fraction only. Total metals concentrations may be significantly higher.

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to about 38.1 cubic feet per second in June. Prickly Pear Creek is an over-appropriated stream that becomes completely dewatered below East Helena (see Chapter IV--Hydrology, Water Resources Development).

Surface Water Quality

Water samples collected during the baseline period from monitoring stations in the study area fail to show any definite trends. Fluctuations in the concentration of metals are moderate. Concentrations of cadmium and arsenic are high over much of the area as a result of mineralization or previous mining activities. Water quality results presented in table III-1 are discussed below for each drainage. Table III-2 presents water quality criteria for aquatic life, public water supplies, recreation, irrigation, and livestock.

Table III-2: Water Quality Criteria Matrix (milligrams per liter unless otherwise noted)

	Cold water aquatic life (mg/l)	Public water supplies (mg/l)	Primary contact recreation (mg/l)	Irrigation (mg/l)	Livestock watering (mg/l)
Conductivity (umhos/cm)				1,800.0	
Dissolved oxygen	7.0				
Fecal coliforms (per 100 ml)			200.0	1,000.0	
pH (minimum)	6.5	6.5	6.5	4.5	
pH (maximum)	8.5	8.5	8.5	9.0	
Temperature (C)	19.4				
Temperature (F)	67.0				
Total dissolved solids		500.0		1,200.0	10,000.0
Total suspended sediment	30.0				
Nitrate as N		10.0			
Nitrite as N	0.05	1.0			10.0
Nitrite and nitrate as N		10.0			100.0
Total ammonia		0.5			
Total inorganic N	1.00				
Total phosphorus	0.10		0.10		
Chloride		250.0		700.0	
Fluoride		2.4		15.0	2.0
Magnesium				160.0	
Sodium				160.0	
Sulfate		250.0			
Arsenic	0.19	0.0		0.10	0.20
Barium		1.00			
Boron				0.75	5.00
*Cadmium	0.0018	0.01			
*Copper	0.02	1.0		5.0	0.5
Iron	1.0	0.3		20.0	
*Lead	0.007	0.05		10.0	0.10
Manganese		0.05		10.0	
Mercury	0.000012	0.002			0.010
*Nickel	0.151	0.015		2.0	
Selenium	0.26	0.01		0.02	0.05
*Silver	0.011	0.05			
Zinc	0.047	5.0		10.0	25.0
Cyanide	.0052	0.2			

*Chronic criteria for Spring Creek based on 182 mg/l hardness as $CaCO_3$.

Clancy Creek: Clancy Creek near the proposed open pit is classified B-1 by Montana Water Quality Standards. It is a good-quality stream with moderately hard, calcium-bicarbonate type water and low concentrations of nutrients. The concentration of metals usually meets all water quality criteria.

Spring Creek: Spring Creek above Corbin is classified B-1 by Montana Water Quality Standards (see Appendix 2). It is a good-quality, calcium-bicarbonate water with low to moderate concentrations of nutrients. Average hardness as calcium carbonate is 182 mg/l. With the exception of arsenic, Spring Creek above Corbin meets quality criteria established for drinking-water supplies.

During periods of snowmelt runoff, upper Spring Creek near Wickes flows for short periods of time. During runoff, the concentrations of arsenic, cadmium, and lead in upper Spring Creek have exceeded criteria developed for drinking water.

The quality of water in Spring Creek below Corbin has been significantly degraded as a result of past mining activities, and should not be used for public consumption (David Stiller and Associates, 1983).

Pen Yan Creek: Pen Yan Creek has poor quality water primarily due to contamination by mine discharge from the Washington Mine. It is a very hard, calcium-sulfate type water with low nutrient concentrations. Concentrations of arsenic, cadmium, lead, zinc, iron, manganese, and total dissolved solids exceed drinking water standards.

Homestake Creek: Water from Homestake Creek is a very hard, calcium-carbonate type with concentrations of arsenic, iron, and manganese that exceed quality criteria established for public water supplies.

Prickly Pear Creek: Numerous studies have been written that document man's debilitating impacts on the quality of water in Prickly Pear Creek (MDHES, 1981). Above the confluence with Spring Creek, Prickly Pear Creek is a good-quality stream. Conductivities, as well as concentrations of suspended sediment, are very low; concentrations of heavy metals are generally below laboratory detection limits.

Downstream of Spring Creek, Prickly Pear Creek has been affected by abandoned mine discharges, railroad and road alignments, industrial pollutants, sanitary wastes, and agricultural dewatering. For example, two miles below Jefferson City, conductivities increase tenfold, and the concentration of heavy metals, such as cadmium, copper, lead, and zinc, do not meet water quality criteria established to protect drinking water and aquatic life. By the time Prickly Pear Creek reaches East Helena, the concentration of these metals decreases dramatically, although still does meet criteria for the protection of aquatic life.

Ground Water

Small to moderate quantities of ground water are present in alluvial and colluvial deposits along major streams and tributaries. Bedrock consists of igneous rocks of the Boulder Batholith with low primary hydraulic conductivity.

The configuration of the ground water table generally reflects topography; this indicates local upland recharge into bedrock fractures and colluvium. Ground water is slowly released from storage at spring and seep sites and is also a source of stream baseflow during summer and fall.

The area near the proposed pit would be located on a local ground water divide (see figure III-4). Water moves from the proposed pit area, recharging Clancy Creek as well as Spring Creek. Recharge through the proposed pit area is small and the movement of ground water through fractures is slow.

Estimated ranges of values for aquifer characteristics are presented in table III-3.

Clancy Creek: Clancy Creek alluvium in the vicinity of the proposed open pit is characterized by 35 feet of gravel and sand saturated below a depth of 11 feet. The alluvium is in good hydraulic connection with Clancy Creek. Aquifer transmissivity is at least 1,800 gallons/day/foot and ground water moves downgradient at about 0.04 feet per foot.

Project Area: Aquifer tests conducted in bedrock in the project area indicate wide ranges of transmissivity reflecting the heterogeneous nature of fractured rock. Estimates of transmissivity range between 660 and 13,200 gallons/day/foot. These values are conservative and actual values may be significantly larger. Storage coefficients range between 0.0015 to 0.012. Ground water flows southeastward toward Spring Creek at a gradient between 0.01 and 0.08 feet per foot.

Spring Creek: Spring Creek alluvium at the proposed production well site is characterized by about 60 feet of sand and gravel. The alluvium is in good hydraulic connection with Spring Creek as well as with underlying fractured bedrock. Aquifer testing indicates that the transmissivity of the alluvial deposit is about 150,000 gallons/day/foot. Underlying bedrock transmissivity is estimated to be about 10,000 gallons/day/foot.

Ground Water Quality

Ground water was sampled from a number of monitoring wells in the project area to determine baseline ground water quality (see figure III-4). Results of these analyses are presented in table III-4 and are discussed below.

Clancy Creek Alluvium: Ground water from Clancy Creek alluvium is characterized from well GW-7. It contains good-quality calcium bicarbonate type water. Concentrations of dissolved cadmium and iron are slightly elevated and dissolved manganese exceeds criteria for public water supplies.

Area of Proposed Open Pit: Ground water from the area of the proposed open pit is characterized from well C-53. Water is very hard, calcium-magnesium, bicarbonate-sulfate type. Total dissolved solids, dissolved iron, and manganese exceed criteria for public water supplies.

Proposed Tailings Dump Area: Ground water downgradient from the tailings deposition area is best characterized by wells GW-4 and GW-5. Ground water in Homestake Creek alluvium apparently has been affected by acid mine drainage.

Table III-3: Estimates of Selected Aquifer Characteristics

Location	Aquifer	Transmissivity (gpd/ft)	Hydraulic conductivity (gpd/ft)^2
Clancy Creek	Alluvium	>1,800	≅75
NW wall-open pit	Diatreme	>30	≅.5
Pit	Diatreme	>660-13,000	≅2-200
SE wall open pit	Andesite	>430	≅10
Waste rock dump	Ignimbrite	>17	≅.2
Spring Creek	Alluvium	>10,000-150,000	≅150-2,500

Source: Project application, 1984.

Water is very poor quality, highly acidic, and contains concentrations of dissolved cadmium, iron, lead, manganese, and zinc, which exceed drinking water criteria. Ground water in Pen Yan Creek alluvium is of better quality, although concentrations of dissolved manganese and iron exceed criteria for drinking water.

Area of Proposed Waste Rock Dump: Ground water in the area of the proposed waste rock dump is best characterized by well GW-3. Water is sodium-bicarbonate type with low concentrations of dissolved solids and metals.

Spring Creek: The Spring Creek alluvium/fractured bedrock system in the area of the proposed production wells contains extremely high-quality, calcium-bicarbonate-type water. Concentrations of total dissolved solids are low and dissolved metals are generally below detection limits.

Abandoned Mine Drainage

Two abandoned mines drain within the proposed permit boundary. Discharges from the Washington Mine contribute about 50 to 75 gallons per minute to the Pen Yan Creek drainage. Various water quality samples indicate that pH fluctuates between 4.5 and 7.5. Concentrations of various heavy metals exceed drinking water standards.

The main entry adit of the Minah Mine discharges iron-bearing, acidic ground water at about 30 gallons per minute. This discharge is lost to channel infiltration (Stiller and Associates, 1983).

Chemical characteristics of acid mine drainage located in the project area are presented in Appendix 3. Over the past few decades, mine drainage has contributed about 80 gallons per minute of recharge to the alluvium and underlying fractured bedrock. As evidenced by the poor-quality water in well GW-4, a contaminant plume is apparently in the process of migrating downgradient toward Spring Creek, and may eventually degrade surface water quality above Corbin.

Table III-4. Ground Water Quality Data from Monitoring Wells

Location	NW wall of pit	Waste rock area	Tailings area	Tailings area	Clancy alluvium	Open pit	Spring Creek alluvium
Well	GW-1	GW-3	GW-4	GW-5	GW-7	C-53	WS-6
Sample Date	09/06/84	09/11/84	09/11/84	10/11/84	09/06/84	06/07/84	04/30/85
Physical parameters							
Spec. cond. (umhos/cm) lab	905	219	1,200	649	194	931	370
pH lab	7.0	7.9	3.2	6.6	6.4	6.4	7.0
Turbidity (NTU) lab	450	55	330	90	80		--
Total dissolved solids	609	144	762	469	138	698	250
Common ions							
Total hardness as $CaCO_3$	515	72	268	326	107	578	--
Calcium (Ca)	124	24	78	96	32	162	54
Magnesium (Mg)	50	3	18	21	7	42	9
Sodium (Na)	16	28	35	20	5	16	11
Potassium (K)						3	1
Alkalinity as $CaCO_3$ (lab)	285	87	0	66	61	252	--
Bicarbonate (HCO_3) (lab)	347	107	0	81	74	307	96
Sulfate (SO_4)	235	28	622	281	52	316	111
Chloride (Cl)	5	5	14	6	3	6	2
Trace Elements							
Arsenic (As) dissolved	<0.055	<0.005	0.006	<0.005	<0.005	0.010	<0.005
Boron (B) total	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	--
Cadmium (Cd) dissolved	0.002	0.003	0.034	0.007	0.005	0.001	0.002
Chromium (Cr) dissolved	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	--
Copper (Cu) dissolved	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron (Fe) dissolved	0.26	<0.03	82.2	0.55	0.11	0.36	0.06
Lead (Pb) dissolved	<0.01	<0.01	1.12	0.03	<0.01	0.01	<0.01
Manganese (Mn) dissolved	0.41	<0.02	20.7	0.54	0.07	1.17	--
Mercury (Hg) dissolved	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	--
Molybdenum (Md) dissolved	<0.005	0.006	<0.005	<0.005	<0.005	<0.005	0.001
Selenium (Se) dissolved	0.009	<0.005	<0.005	<0.005	<0.005	0.005	<0.005
Silver (Ag) dissolved	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	--
Zinc (Zn) dissolved	0.09	0.02	6.56	0.41	0.06	0.19	0.06
Other Parameters							
Cyanide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	

All quantities in milligrams per liter unless otherwise noted.

Blank line indicates parameter not tested.

AQUATICS

Macroinvertebrates (bugs) and diatoms (microscopic, one-celled plants) of streams within and near the project area have been studied by the Department of Health and Environmental Sciences (DHES 1981 and 1977), David Stiller and Associates (1983), the Department of Fish, Wildlife and Parks (1971), Streamworks (1984) and, more recently, by Centennial Minerals, Inc. (project application, 1984). Streams of importance relative to aquatic organisms are Prickly Pear Creek; Clancy Creek; and Spring Creek (see figure III-4).

Spring Creek

Spring Creek contributes tremendous loads of sediment and heavy metals to Prickly Pear Creek (DHES, 1981, 1977). The major source of these pollutants are the Corbin Flats tailings, Corbin Creek, the Bertha Mine and mill, and the Alta Mine (Stiller and Associates, 1983). Above Corbin, streamflow near abandoned mines in the proposed project area is ephemeral or intermittent, and surface discharges associated with the Bluebird, Minah, and Washington mines are lost to channel infiltration. The impact these drainages have had on water quality in upper Spring Creek is not known; however, baseline studies indicate that a viable macroinvertebrate population exists in Spring Creek in a short perennial reach upstream of Corbin Creek. Macroinvertebrate collections (project application, 1984) from two sampling stations in this short reach yielded a mean of 29 taxa per station (mean number of individuals, 920). Calculated diversity at each sampling station was 4.11 and 4.37, an indicator of a healthy macroinvertebrate community and excellent water quality (DHES, 1981). Taxa collected at these two sites included stoneflies, mayflies, caddisflies, true flies, and aquatic beetles. Diatom diversity was also high (3.91) at a nearby sampling station at the bridge south of Corbin (DHES, 1977). However, this healthy aquatic condition may not continue into the future. Contaminated ground water emanating from the Washington and Minah mines may someday impair existing aquatic life.

Severe acid drainage, toxic metals, and sediment from the Alta Mine, Bertha Mine and mill, and Corbin Creek road severely affect aquatic macroinvertebrates in Corbin Creek (Stiller and Associates, 1983; project application, 1984). Aquatic macroinvertebrates found in Corbin Creek below the Bertha Mine and Alta Mine discharge are mostly pollution-tolerant forms (true flies and beetles) and are few in number.

Below Corbin, Spring Creek biota are adversely affected by metals and sediment from Corbin flat tailings, Corbin Creek, and poor channel substrate. Total numbers of taxa and macroinvertebrates collected from two stations in this reach (project application, 1984) were significantly lower compared to the upper stations and, in fact, were too low for calculating diversity values. Mean taxa per station was 13 and mean total individuals 86. Diatom diversities in Spring Creek below Corbin and at Jefferson City were below threshold levels indicating significant impact (DHES, 1977). Diatom diversity values for these two stations were 0.996 and 0.061.

Of all the tributaries, Spring Creek probably has the most profound affect on the macroinvertebrate and diatom community of Prickly Pear Creek.

Above Spring Creek, macroinvertebrate and diatom diversities of Prickly Pear Creek are 4.22 and 4.30. Below Spring Creek, diversity drops by a third (2.90) for macroinvertebrates and by a half (1.84) for diatoms (DHES, 1981). The benthic community never fully recovers downstream, even to the mouth of Prickly Pear Creek, although other sources of pollution are also factors in the degradation.

Clancy Creek Subdrainage

With the exception of Gregory Gulch, Clancy Creek and its tributaries have a diverse community of aquatic macroinvertebrates (Stiller and Associates, 1983; project application, 1984) and diatoms (DHES, 1977). Gregory Gulch is affected by discharges from the Gregory Mine. Macroinvertebrate diversities for stations sampled on Clancy Creek range from 3.64 to 3.94. These diversities generally indicate excellent water quality conditions. The mean taxa collected per station was 28 and mean total numbers of individual organisms was 868.

FISHERIES

Spring Creek and Clancy Creek

The fish populations of Spring Creek and Clancy Creek were sampled by electroshocking (Montana Department of Fish, Wildlife, and Parks in project application, 1984). Sampling was conducted in October, 1984 in two 1,000-foot sections of Clancy Creek and one 1,000-foot section of Spring Creek (figure III-5). Population estimates were made using a mark-and-recapture method.

Brook trout accounted for 648 of the 653 fish captured in Spring Creek (see Appendix 6 for scientific names). The brook trout population was estimated at 934 individuals (table III-5). Five rainbow trout caught ranged from 2-1/2 to 8-1/2 inches long.

Only cutthroat trout were caught in Clancy Creek above Kady Gulch. The 27 individuals ranged from 2 to 7 inches in length. About 60 percent of the fish were in the 3- to 4-inch length class. A population estimate was not made.

The fish sample taken from the lower section of Clancy Creek was comprised of 430 brook trout, 5 rainbow trout, 3 brown trout, and 1 cutthroat trout. The brook trout population was estimated at 772 individuals with most fish under 3 inches long (table III-5). The browns and rainbows ranged from 5- to 9-inches long. The cutthroat was about 8 inches long.

Prickly Pear Creek

Streamworks (1984) used reports from the Montana Department of Fish, Wildlife and Parks to describe fish populations of Prickly Pear Creek. Their summary stated that trout do not live year-round immediately below the confluence of Spring Creek and Prickly Pear Creek. The absence of a resident

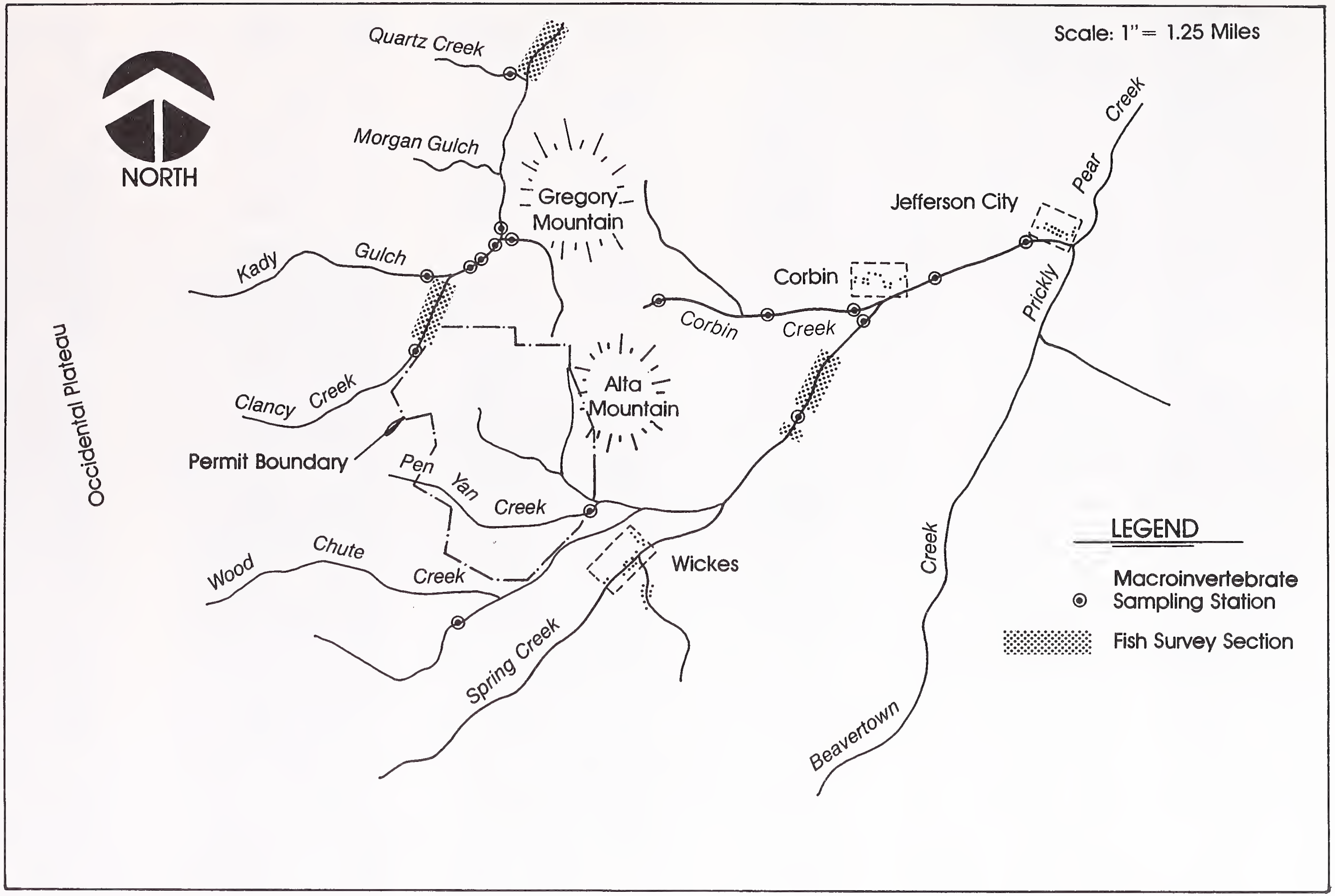

Figure III-5
Macroinvertebrate and fish sampling stations are scattered along creeks in the project area.

Table III-5: Brook Trout Population Characteristics

Sampling location	Number caught	Age class	Mean length (inches)	Number estimate[1]
Spring Creek	644	0	3.2	675
		I	5.3	206
		II	7.1	37
		III	8.7	14
		IV	9.1	2
				934
Clancy Creek below Quartz Creek	439	0	3.0	607
		I	5.1	53
		II	6.6	51
		III	8.3	52
		IV	10.0	9
				772

Source: Montana Department of Fish, Wildlife and Parks *in* project application, 1984.

[1] Rounded to the nearest whole number. Estimate made using a mark-and-recapture method.

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trout population is indicative of poor-quality water (see Chapter III--Hydrology). However, trout have been captured in upper Prickly Pear. These fish have probably adapted to the poor-quality water or use this area during seasonal improvements in water quality. Traynor (1969) found 16 brook trout and 5 rainbow trout (see Appendix 6 for scientific names) in an electroshocked sample. Although three rainbow were nearly 11 inches long, most fish were under 5 inches. Baker and Baldigo (1983) captured a total of 43 brook trout and rainbow trout near the Prickly Pear/Spring Creek confluence. MDFWP studies indicate that upper Prickly Pear Creek contains a relatively low number of fish.

Roughly 2-1/2 miles below Spring Creek, rainbow trout become more common. At about 7 miles below Spring Creek, almost equal numbers of rainbow and brown trout have replaced brook trout as the predominant species. Mottled sculpins were also found in this stretch of the stream. In 1972, fish populations were sampled on Prickly Pear Creek about 2-1/2 miles upstream from Montana City. The population estimate was 79 rainbow and 90 brown trout per acre. Biomass was estimated at 73 pounds per 1,000 feet. This biomass can be considered average for a Montana trout stream.

SOILS

In general, the soils of the proposed permit area are naturally acidic, high in coarse fragments (gravels and cobbles), and vary widely in depth. Soil permeabilities are moderately rapid to rapid, and water- and nutrient-holding capacities are low. Slopes are moderate to very steep throughout most of the permit area; however, the north-central uplands and alluvial terraces to the south have gentler slopes. Rock outcrops occur most commonly in the northern and western portions of the proposed permit area. Soil parent materials for all soils in the proposed permit area consist of either alluvium (water-deposited materials), colluvium (material that has moved downhill as a result of gravity), or residual volcanic material (material formed in place from the weathering of underlying volcanic rock).

Within the proposed permit area, 14 soil series and one phase have been identified and placed into 17 mapping units. In addition, a "disturbed" mapping unit was used to identify areas where natural soils have been buried, contaminated, or otherwise disturbed by past mining and related activities. For ease of discussion, the soil mapping units have been placed into three major soil groups based on similarities in parent material:

--alluvial/colluvial soils,
--residual volcanic soils, and
--alluvial/colluvial/volcanic soil complex.

The locations of these three soil groups (as well as the disturbed soils) within the proposed permit area are shown on figure III-6. For a complete listing of mapping units proposed for disturbance, as well as the amount of soil by unit proposed for salvage, see table II-5.

Alluvial/Colluvial Soils

The alluvial/colluvial soils group covers about 43 percent of the proposed permit area (figure III-6). The group includes very shallow to deep soils that developed in alluvium, colluvium, or a mixture of both.

The soils in this group vary somewhat in physical and chemical characteristics and degree of soil development. The individual soil characteristics are determined largely by the original source of the alluvium and colluvium, the degree to which these materials were sorted as they were being deposited, and the local microenvironment in which these soils developed.

The predominant soil texture in this group is gravelly or cobbly sandy loam; textures range from gravelly or cobbly sandy clay loam to gravelly or cobbly sand. Coarse fragment content is extremely variable, ranging from 0 to 80 percent by volume. In every case, coarse fragment content is much less in the surface layers and increases with depth. The pH of these soils ranges from 5.3 (strongly acid) in a Douglas-fir forest to 7.0 (neutral) in an aspen grove. Except for potassium, soil nutrient levels are low. Trace element concentrations are also quite low, except for the J1 soil series, which has elevated levels of manganese and zinc. The manganese and zinc levels are probably high as a result of the minerals in the parent material, and not because of mine-related contamination.

The alluvial/colluvial soils group is found throughout the proposed permit area. Rangeland vegetation associated with this soils group includes rough fescue, Idaho fescue, bluebunch wheatgrass, prairie junegrass, big sagebrush, Kentucky bluegrass, and numerous forbs. Douglas-fir, ponderosa pine, antelope bitterbrush, sedges, and pinegrass dominate the coniferous forest

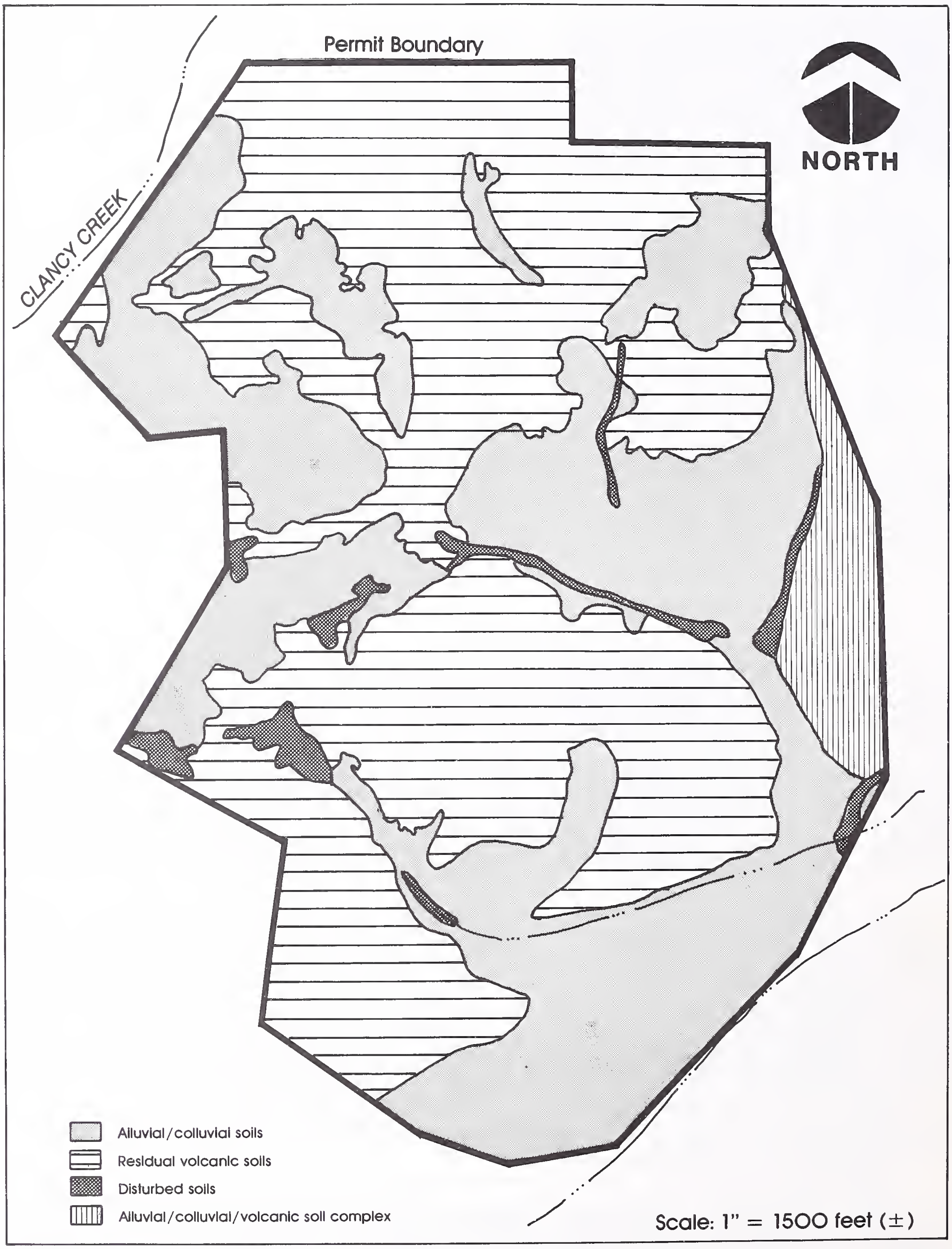

Figure III-6

The soils in the proposed project area, divided into four base groups, reflect their parent materials.

soils in this group (see Appendix 5 for scientific names). Aspen groves in this soils group contain quaking aspen, mixed shrubs, and grasses.

Residual Volcanic Soils

The residual volcanic soils group covers about 51 percent of the proposed permit area (figure III-6), and contains shallow to moderately deep soils that were formed in place from underlying volcanic rock. The predominant soil texture in this group is gravelly or cobbly loamy sand; textures range from gravelly sandy clay loam to very cobbly loamy sand. Coarse fragment content is extremely variable, ranging from 5 to 75 percent. In all cases, coarse fragment content is much less in the surface layers and increases with depth.

The pH of these soils ranges from 4.8 (very strongly acid) in a Douglas-fir forest to 6.1 (slightly acid) in rangeland soils. Except for potassium, soil nutrient levels are low. Trace element concentrations are also low. An exception to this is the J soil series, where lead and manganese levels are elevated. The elevated levels of these two trace elements is probably due to the minerals present in the parent material.

The residual volcanic soils are found throughout the proposed permit area. Coniferous forest vegetation found on these soils includes Douglas-fir, lodgepole pine, pinegrass, and sedges. Rangeland vegetation found in this soils group includes Idaho fescue, rough fescue, bluebunch wheatgrass, prairie junegrass, Kentucky bluegrass, and numerous forbs.

Alluvial/Colluvial/Volcanic Soil Complex

This soils group consists of only the FEA soil complex mapping unit, and covers about four percent of the proposed permit area (figure III-6). This group consists of three soils mapped together in one mapping unit as a complex because, where this unit occurs, the individual soils could not be delineated separately at the map scale used for this survey. Two of the soils (A and F soils series) are alluvial/colluvial soils, and have the same characteristics previously discussed for that soils group. The third soil (E series) is a residual volcanic soil, and has the same characteristics discussed above for that group.

This soils group is found only along the eastern edge of the proposed permit area. This group primarily supports rangeland vegetation such as Idaho fescue, rough fescue, bluebunch wheatgrass, prairie junegrass, and numerous forbs; however, scattered clumps of Douglas-fir and ponderosa pine can be found throughout this soils group.

Disturbed Soils

The disturbed soils mapping unit consists of areas where soils have been buried, contaminated, or otherwise disturbed by past mining activities. This unit covers about two percent of the proposed permit area (figure III-6). Some soils in this unit have been buried by tailings and waste rock, or disturbed by roads, exploration pits, and mill sites. Soils in this unit that have been indirectly affected are those in drainages that have been contaminated by trace elements from sediment washed down from upstream disturbances. For the most part, very little vegetation exists within this unit.

VEGETATION

The 1,549-acre vegetation study area included the proposed permit area. Nine climax vegetation types, one seral vegetation type, and four disturbed types were identified during 1984 baseline surveys (Westech, 1984). Although grasslands make up over half of the study area, forested areas are also common (table III-6).

The field study identified 236 plant species (table III-6). The rough fescue/bluebunch wheatgrass vegetation type contains the greatest number of species (see Appendix 5 for scientific names). No federally listed threatened plant species or rare plants were found in the study area (U.S. Fish and Wildlife Service, 1984, and Lesica et al., 1984).

Based on 1977 Soil Conservation Service methods, most rangeland--nonforested and undisturbed--in the study area is in good condition (60 percent of climax). Condition by vegetation type is:

--Idaho fescue/bluebunch wheatgrass--good (55 percent),
--Rough fescue/bluebunch wheatgrass--good (69 percent),
--Rough fescue/Idaho fescue--good (71 percent),
--Big sagebrush/Idaho fescue--fair (38 percent),
--Bitterbrush/rough fescue--good (57 percent).

Lower slopes and benches near water are grazed most heavily by livestock.

Vegetation Type Descriptions

Idaho Fescue/Bluebunch Wheatgrass

Of the three grassland types, Idaho fescue/bluebunch wheatgrass occupies the drier sites. Idaho fescue is the dominant grass, making up 25 percent of the vegetation cover. Bluebunch wheatgrass is the next most common grass followed by prairie junegrass and needle-and-thread. Forb cover comprises 27 percent of the vegetation cover, with silky lupine, ballhead sandwort, tufted fleabane, and common dandelion constituting much of this cover; this type ranks second as a producer of livestock forage. Although herbaceous plants dominate, shrubs are commonly encountered; green rabbitbrush is the most prevalent species (table III-7).

Rough Fescue/Bluebunch Wheatgrass

Rough fescue dominates this type and bluebunch wheatgrass and Idaho fescue are both abundant. Forbs, especially silky lupine, sulfur buckwheat, and hairy golden aster, increase the production of livestock forage. Shrubs, most notably green rabbitbrush, are scattered throughout this type.

Table III-6: Vegetation Types in the Study Area

Vegetation type in Montana Tunnels area	Number of sampling transects	Number of species recorded	Study area Acres	Study area Percent	Disturbance area Acres	Disturbance area Percent
Idaho fescue/bluebunch wheatgrass	6	85	378	24	283	29
Rough fescue/bluebunch wheatgrass	9	108	392	25	170	18
Rough fescue/Idaho fescue	5	95	67	4	46	5
Big sagebrush/Idaho fescue	2	58	13	1	10	1
Bitterbrush/rough fescue	4	87	97	6	63	7
Douglas-fir/Idaho fescue	4	100	60	4	32	3
Douglas-fir/rough fescue	5	103	223	14	123	13
Douglas-fir/elk sedge	2	60	20	1	20	2
Douglas-fir/pinegrass	5	64	155	10	119	12
Quaking aspen	3	68	26	2	21	2
Cropland	0	0	45	3	45	5
Hayfield	0	0	8	1	0	0
Tame pasture	0	0	3	<1	0	0
Miscellaneous disturbed	0	0	60	4	33	3
	45	236[1]	1,549[2]	100[3]	965	100

Source: Westech, 1984.

[1] The same species were often recorded in more than one type; therefore, the column does not total 236.

[2] Includes 2 acres of small stands of Douglas-fir types that were not sampled.

[3] Rounded to 100.

Rough Fescue/Idaho Fescue

Rough fescue and Idaho fescue dominate this type. Bluebunch wheatgrass and shrubs appear less frequently than in the other grassland types. The growth habit of Wood's rose probably accounts for the high density of shrub stems shown in table III-7. Forbs, notably silky lupine, prairiesmoke, Missouri goldenrod, and sulfur buckwheat, are intermixed with the grasses. On a per-acre basis, the rough fescue/Idaho fescue type produces the most total livestock forage.

Big Sagebrush/Idaho Fescue

Big sagebrush visually dominates this vegetation type. Antelope bitterbrush occurs occasionally in the overstory. Kentucky bluegrass is the most common understory plant. Idaho fescue and needle-and-thread are scattered beneath the sagebrush. Sulfur buckwheat, Missouri goldenrod, and rose pussytoes comprise the majority of the forb cover. The high level of shrub production corresponds with the low level of livestock forage production.

Table III-7: Production and Woody Plant Densities of Vegetation Types, 1984

Vegetation type in the Montana Tunnels area	Production of perennial grasses and forbs (lbs/acre/year)	Production of shrubs[1] (lbs/acre/year)	Coniferous tree density (number/acre)	Deciduous tree density (number/acre)	Shrub density[2] (number/acre)
Idaho fescue/bluebunch wheatgrass	971	26	--[3]	--	5,760
Rough fescue/bluebunch wheatgrass	899	9	--	--	8,234
Rough fescue/Idaho fescue	1,301	14	--	--	15,664
Big sagebrush/Idaho fescue	566	1,131	--	--	73,853
Bitterbrush/rough fescue	944	476	--	--	23,404
Douglas-fir/Idaho fescue	233	215	490	--	7,164
Douglas-fir/rough fescue	480	15	353	--	15,216
Douglas-fir/elk sedge	--	--	933	--	3,952
Douglas-fir/pinegrass	--	--	544	--	2,766
Quaking aspen	--	--	69	884	138,073

Source: Westech, 1984.

[1] Shrub production estimated by a non-harvest method (Weaver, 1977).

[2] Number of live stems per acre. This number is not always identical to the number of plants per acre.

[3] No estimate made.

Bitterbrush/Rough Fescue

Bitterbrush dominates the shrub overstory in this type. Beneath the shrubs, grass cover averages 31 percent. Important grasses include Kentucky bluegrass and bluebunch wheatgrass. Cheatgrass, an annual grass, is also common. Dalmation toadflax and sulfur buckwheat make up over half of the 22 percent forb cover.

Douglas-fir/Idaho Fescue

Douglas-fir dominates this forested type; it forms a canopy of 47 percent and occurs at 482 trees/acre. The relatively open overstory allows for production of 233 pounds per acre of herbaceous material. Total understory vegetation averages 19 percent cover. Grass cover and forb cover are equal at 9 percent. Idaho fescue and bluebunch wheatgrass are the dominant grasses. Dominant forbs include rose pussytoes, Missouri goldenrod, and western yarrow.

Douglas-fir/Rough Fescue

The relatively open canopy of this type is comprised mostly of Douglas-fir. Ponderosa pine is a minor tree species. Bitterbrush commonly grows below the forest canopy. For a forested type, livestock forage production is high. Forage species include rough fescue, Kentucky bluegrass, bluebunch wheatgrass, and Idaho fescue. Dominant forbs in this vegetation type are arrowleaf balsamroot, sulfur buckwheat, rose pussytoes, and western yarrow.

Douglas-fir/Elk Sedge

The overstory of this type is dominated by either Douglas-fir or lodgepole pine. Those stands dominated by Douglas-fir are relatively open and have productive understory. However, the undeveloped understory of the lodgepole pine stands offsets the productivity of the Douglas-fir stands. In both types of stands, elk sedge is the dominant understory plant. Some forbs, including woodland strawberry and littleleaf penstemon, are found on the forest floor.

Douglas-fir/Pinegrass

Douglas-fir is the only significant tree found in this vegetation type. The relatively closed canopy has limited the development of the understory. Shrubs are uncommon and grasses cover less than 3 percent of the forest floor. Forbs growing in this type include marsh valeriana, showy aster and littleleaf penstemon.

Quaking Aspen

Twenty-six acres of aspen woodlands are found in the study area. The tree canopy is 79 percent and is mainly composed of aspen. The presence of reproducing Douglas-fir among the aspen suggests that this vegetation type is in a seral state. Despite the dense tree cover, the understory is well developed. Moist soils have allowed shrubs to attain a cover of 21 percent. The important shrubs are Wood's rose, common snowberry, and red raspberry. Grass cover averages about 7 percent with Kentucky bluegrass, pinegrass, and slender wheatgrass being encountered most often. Forb cover is about twice that of grass. Showy aster, veiny meadowrue, mountain sweetroot, northern bedstraw, iris, and dandelion are common forbs.

Cropland

In 1984, a 45-acre field in the northeast corner of the study area was seeded with alfalfa, wheatgrass, and orchardgrass. Oats, seeded as nurse crop, has apparently become the dominant species. Weeds are common and current yields are considered low. Harvests made in the 1950s indicate the field is capable of annually producing 2 tons per acre of oats and barley.

Hayfield

This 8-acre hayfield annually produces about 1-1/2 to 2 tons per acre of introduced perennial grasses. Horses are allowed to graze the hayfield after each harvest.

Tame Pasture

A small pasture runs along a segment of Clancy Creek. Dominant grasses include Kentucky bluegrass, timothy, redtop, and slender wheatgrass. Wood's rose is a common shrub.

Miscellaneous Disturbed

Previously disturbed lands total 60 acres in the study area. Most disturbance is due to past mining and includes waste rock dumps, tailings sites, ditches, and buildings. The sparse vegetation found on these sites is due to the inadequacy of disturbed material for plant growth or the steep slopes. Other disturbed areas include roads, ranch sites, and an abandoned railroad grade.

WILDLIFE

From May 1984 through April 1985 wildlife surveys were conducted in the Montana Tunnels study area (Westech, 1985). Twenty-three mammal species and 87 bird species were recorded; reptiles or amphibians were not observed. The study area contains elk and mule deer range and provides habitat for black bears and coyotes (see Appendix 6 for scientific names).

Vegetation and topography combine to meet the habitat requirements of various animals. Wildlife habitat (table III-8) types were based on existing vegetation and correspond to previously described vegetation types (see Chapter II--Vegetation). Most of the study area consists of grasslands or the

Table III-8: Wildlife Habitat Type and Corresponding Vegetation Types

Wildlife habitat type in Montana Tunnels wildlife study area	Acres	Percent of mapped study area[2]	Corresponding vegetation type
Douglas-fir/grass	3,589	35	Douglas-fir/Idaho fescue Douglas-fir/rough fescue Douglas-fir/elk sedge Douglas-fir pinegrass
Douglas-fir/bitterbrush	285	2.8	Douglas-fir/Idaho fescue Douglas-fir/rough fescue
Douglas-fir/ponderosa pine/bitterbrush	41	0.4	Douglas-fir/Idaho fescue Douglas-fir/rough fescue
Douglas-fir/ponderosa pine/grass	237	2.3	Douglas-fir/Idaho fescue Douglas-fir/rough fescue
Ponderosa pine/grass	18	0.2	--[3]
Ponderosa pine/Douglas-fir/grass	11	0.1	--[3]
Lodgepole pine	7	0.1	Douglas-fir/elk sedge
Aspen	64	0.6	Quaking aspen
Willow	130	1.3	Miscellaneous disturbed
Deciduous shrub	78	0.8	Rough fescue/Idaho fescue
Bitterbrush/grassland	267	2.6	Bitterbrush/rough fescue
Bitterbrush/deciduous shrub	84	0.8	Bitterbrush/rough fescue
Big sagebrush/grassland	25	0.2	Big sagebrush/Idaho fescue
Grassland	5,082	49.6	Idaho fescue/bluebunch wheatgrass Rough fescue/bluebunch wheatgrass Rough fescue/Idaho fescue Tame pasture
Cropland	87	0.8	Cropland
Hayfield	81	0.8	Hayfield
Miscellaneous disturbed	154	1.5	Miscellaneous disturbed
TOTAL	10,240[1]	100	

Source: Westech, 1985.

[1] Includes some habitat types too small for mapping (logging, rock outcrop/talus/scree, impoundment, Douglas-fir/deciduous shrub, and ponderosa pine/bitterbrush).

[2] The 16 square mile ground study area was mapped with ±15 percent accuracy. Total percentage was rounded to 100.

[3] Not covered by the vegetation study (Westech, 1984). The ponderosa pine/Douglas-fir/grass is similar to the Douglas-fir/Ponderosa pine/grass. The ponderosa pine/grass is represented by small stands of ponderosa pine on Alta Mountain.

Douglas-fir/grass type. Gentle to moderate slopes, dominated by east and south aspect, characterize the study area.

Elk

Between May 1984 and April 1985, 94 observations totalling 1,481 elk were made in the study area. Only one observation was made in the summer (June 16 to September 15). By fall (September 16 to November 30) observations increased to 11. Observations peaked in the winter (December 1 to March 31) at 55 and fell to 27 in the spring (April 1 to June 15).

During the spring, elk were found primarily in the western half of the study area. They apparently spent the summer west of the study area. Elk began returning to the study area in the fall. Eight observations were scattered throughout the western portion of the study area. The three other elk groups were seen between Gregory and Alta mountains.

The 55 winter observations were used to identify elk winter range (figure III-7). Four concentration areas within the winter range include Gregory Mountain, Kady Gulch/Morgan Gulch, Washington Hill, and Spring Creek/Boulder River. Animals frequently move between the Gregory Mountain and Kady Gulch/Morgan Gulch areas; these areas may be part of the winter range during mild winters. There was considerably less movement from Gregory Mountain to the Washington Hill concentration area. Elk also traveled across Locker Flats between the Washington Hill and Kady Gulch/Morgan Gulch areas. In milder winters, Locker Flats may serve as winter range. Elk from the above-mentioned areas may move to other ranges north and east of the study area. Elk from the Spring Creek/Boulder Creek concentration area probably did not mix with elk from the rest of the study area. In general, all winter ranges were characterized by south aspects and reduced snow depths due to wind action.

Elk were sighted in five habitat types: Douglas-fir/grass, Douglas-fir/bitterbrush, bitterbrush/grass, big sagebrush/grass, and grassland (table III-9). Grasslands accounted for the vast majority of observations (78 percent of groups observed and 90 percent of individuals observed). The Douglas-fir/grass type was the only other type to contribute substantially to the observation total (18 percent of groups observed and 9 percent of individuals observed). Elk use and habitat availability were compared to determine that these two types were also preferred by elk. The importance of grassland as elk habitat was further confirmed by the abundant pellet groups found along grassland transects. Even when analyzed seasonally, grassland and Douglas-fir/grass continued to be the only important habitat types (table III-9).

Aspect and slope are important components of elk winter range. They influence snow depth which, in turn, determines the intensity of elk use. Southern aspects (south, southeast, southwest) made up 44 percent of the study area and contributed 68 percent of the winter observations. Within identified winter range, southern aspects constituted 57 percent of the area and accounted for 68 percent of the observations. Elk appeared to favor the southwest aspect. Moderate slopes (11 to 40 percent), the most prevalent slope category in the study area, accounted for 75 percent of elk sightings during winter. However, preference indices were highest for level terrain.

Wind and sunshine act to limit snow depths to less than 6 inches on elk winter range. These factors are most effective on south and west aspects, steep slopes, and open habitats. Large portions of the concentration areas

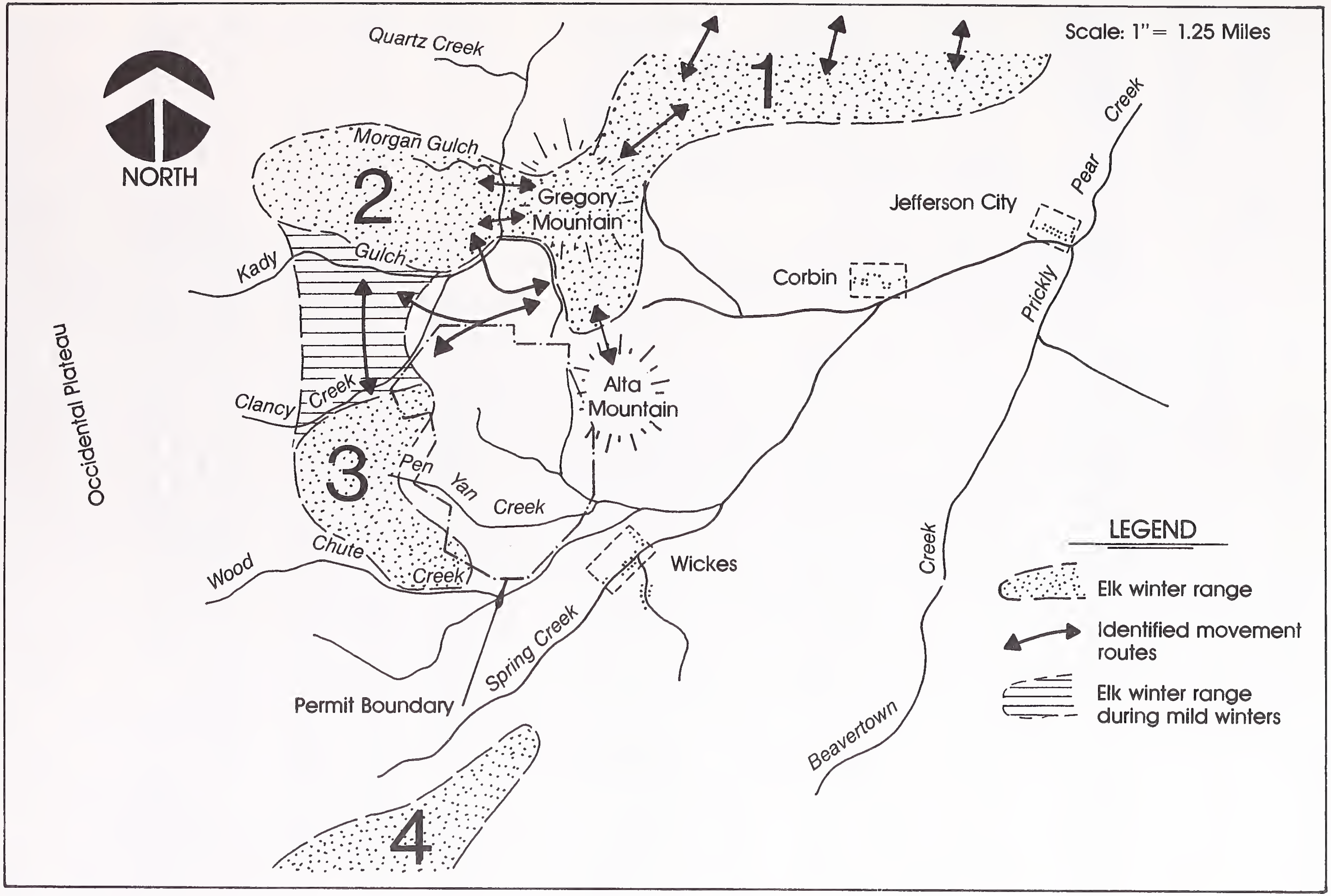

Figure III-7

The permit area slightly overlaps elk range. Elk occasionally travel across the proposed project site, concentrating in the Gregory Mountain area (1), the Kady/Morgan Gulch area (2), the Washington Hill area (3), and the Spring Creek/Boulder River area (4).

Table III-9: Percentage of Elk Group Sightings by Habitat Type

	Habitat types[1]					Sample size	
Month	Douglas-fir/ grass	Douglas-fir/ bitterbrush	Bitterbrush/ grass	Big sagebrush/ grass	Grassland	Groups	Individuals
1984							
May	15%				85%	13	83
June						0	0
July					100%	1	1
August						0	0
September			33%		67%	3	20
October						0	0
November	38%				63%	8	60
December	22%	11%			67%	9	190
1985							
January	25%				75%	20	553
February	31%				69%	16	279
March					100%	9	200
April				7%	93%	15	105

Source: Westech, 1985.

Note: Montana Tunnels Wildlife Study Area, May 1984 to April 1985. Percentages do not always total 100 due to rounding. Blanks within the table indicate that no observations were made.

[1] Elk were not sighted in other habitat types (table III-8).

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were snow-free during winter, 1984-1985. The travel routes used most often had less than 16 inches of snow. Elk generally avoided areas with more than 2 feet of snow.

Aerial surveys were used to estimate the elk population in the study area. The highest single count (173 elk) occurred in late January. This number represents the minimum elk population in the study area. Elk densities were 4.3 per square mile in the entire study area and 6.9 per square mile in winter range.

The elk population of the study area was characterized by a high portion of adult females with low calf production; the calf-to-cow ratio was only 5 to 100. Of the 129 elk classified, 93 percent were adult females; only 2.3 percent were adult males. Reasons for the low bull numbers and low calf production are unknown; however, hunting and poaching could be controlling the number of bulls.

All recorded elk mortality in the area was caused by humans. Evidence of poaching was noted on Gregory Mountain in January 1985 and in Kady Gulch in May 1984. The study area falls within MDFWP Hunting District 435. In 1984, 101 elk were harvested from this district (J. Mitchell, MDFWP, pers. comm., September 30, 1985).

Mule Deer

Mule deer were the most commonly observed big game animal during the baseline study. However, the 169 observations totalled only 438 animals compared to 1,481 individual elk, indicating elk are seasonally more abundant than deer. Elk groups were also larger than deer groups.

Forty-two observations of mule deer were made in the spring. Deer observations, scattered throughout the western two-thirds of the study area, increased in the summer to total 86 (figure III-8). Deer remained in the western part of the study area during fall; however, observations decreased to 29.

Only eight groups of deer were sighted over the winter. However, these data contrast with information supplied by agency biologists and area residents, who indicated that the study area contained winter range for mule deer (figure III-9). Westech (1985) suggests that most deer move through this range to winter in areas north and east of the study area.

Although mule deer were observed in 12 habitat types, the grassland and Douglas-fir/grass types were particularly important habitats (table III-10). On a year-round basis, grasslands contributed 43 percent of observations and Douglas-fir/grass accounted for 22 percent. Deer apparently preferred shrub types or forests with a shrub understory. Although these types made up only a small portion of the study area (table III-8), they contributed a relatively large number of observations. Pellets were often found along transects in bitterbrush types, indicating frequent deer use.

The seasonal pattern of habitat use begins in spring with deer foraging in habitats with a grass understory. Kufeld et al. (1973) also noted the attraction of deer to grass during the spring "green-up" period. Foraging on grasses continued throughout the summer although increasing numbers of deer used shrub habitats. By fall, 20 percent of observations came from the bitterbrush/grass type. Of the eight winter observations, five were made in the bitterbrush/grass type. Due to the low number of winter observations, slope and aspect use were not analyzed.

During an aerial count on April 30, 1985, the minimum deer population was estimated to be 89. This count represents 2.2 deer per square mile throughout the study area. Before the hunting season, the buck/doe ratio estimate was 31:100; hunting changed the ratio to 13:100. Fawn production was low, ranging from 39 fawns for every 100 does before hunting to 50 fawns for every 100 does after hunting. The accuracy of the above ratio is, however, limited by the small sample size (95 deer classified between September and December).

The presence of fawns with does in June suggests that fawning occurs on the study area. However, specific fawning areas were not identified. Recorded deer mortality was due to hunting or poaching. In 1984, 291 deer were killed legally in Hunting District 435 (J. Mitchell, MDFWP, pers. comm., September 30, 1985). Poaching attempts were noticed along Clancy Creek and on the Occidental Plateau.

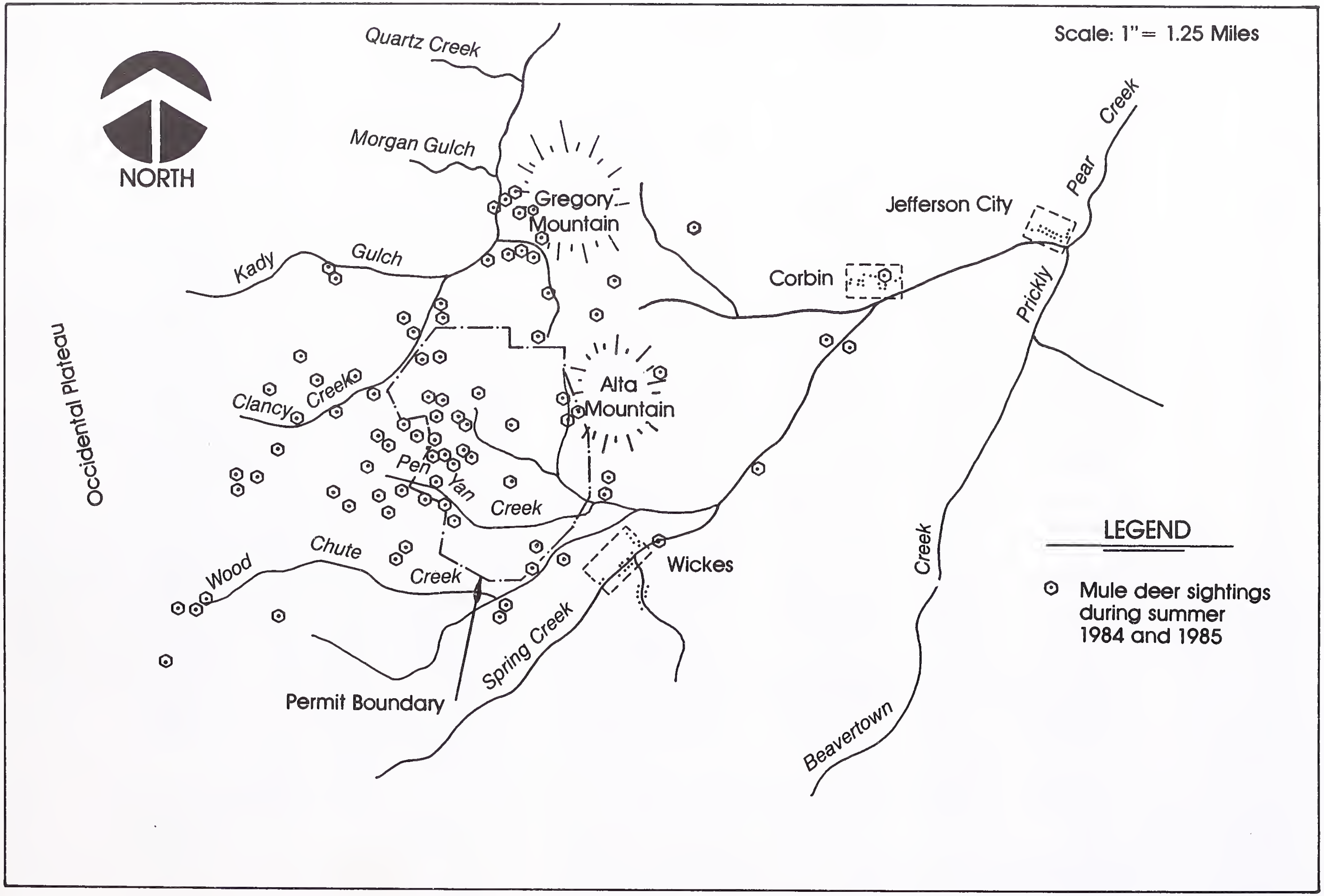

Figure III-8
Most mule deer were sighted during the summer. The permit area accounted for 24 observations.

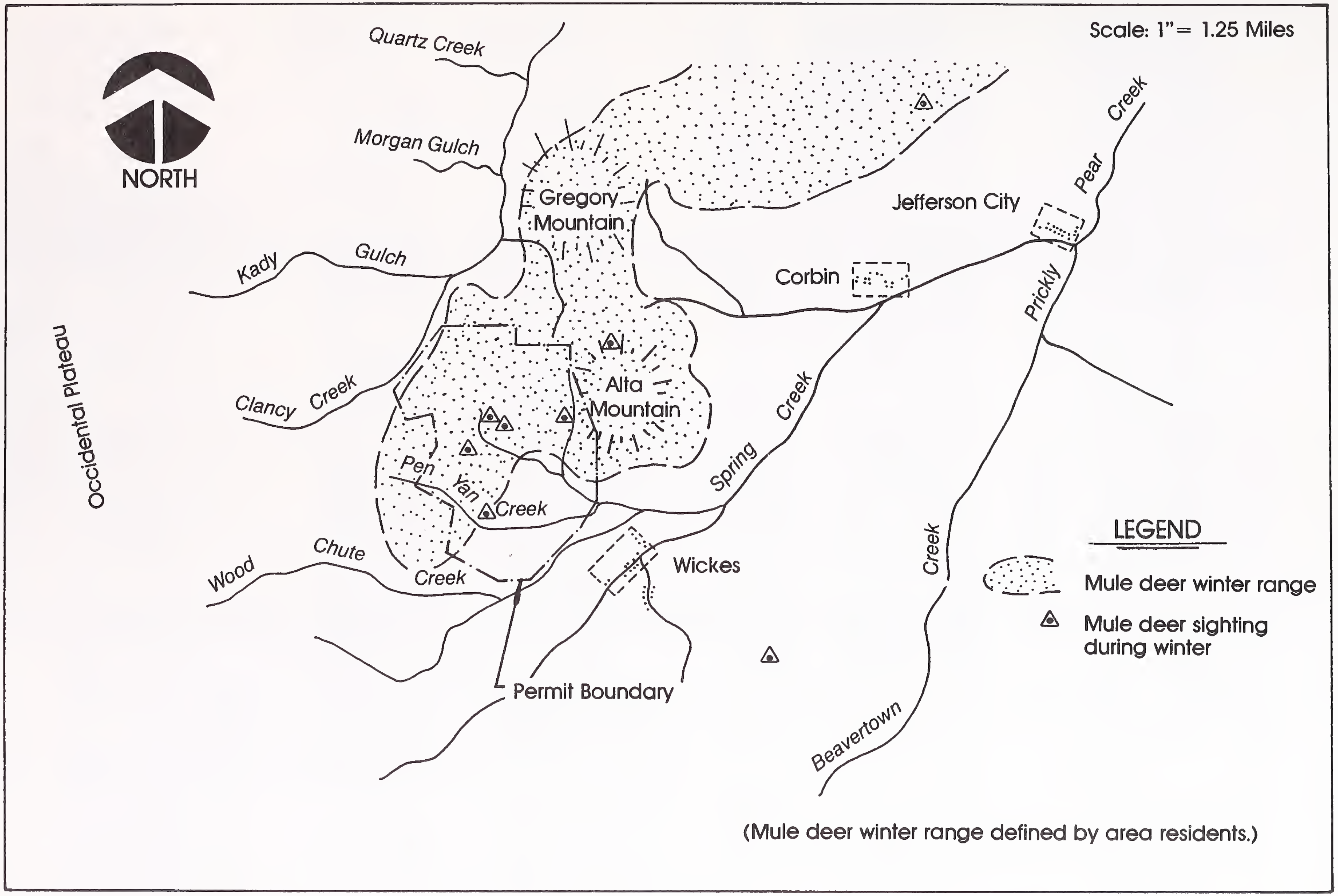

Figure III-9

Agency biologists and area residents identified a mule deer winter range that falls within the proposed permit area. Westech (1985) observed only 8 deer groups on this area.

Table III-10: Percentage of Mule Deer Group Sightings by Habitat Type

Month	Habitat type[1]												Sample size Number Observed	
	Douglas-fir/ grass	Douglas-fir/ bitterbrush	Douglas-fir/ deciduous shrub	Ponderosa pine/ grass	Lodgepole pine	Aspen	Willow	Deciduous shrub	Bitterbrush/ grass	Big sagebrush/ grass	Grass	Disturbed	Groups	Individuals
1984														
May	26		5	11		16					42	5	19	70
June	33		3		3	3	3	3	12		39		33	50
July	29		3		3	12	1				38	12	34	49
August	22	22	11			11		11			22		9	15
September	21		7			25	4		7		39		28	66
October									75		25		4	7
November	40	20							10		30		10	25
December									100				1	3
1985														
January									75		25		4	35
February													0	0
March			33						33		33		3	9
April	5								5	5	86		22	112

Source: Westech, 1985.

Note: Data were collected from May, 1984 to April, 1985, Montana Tunnels Wildlife Study Area. Percentages do not always total 100 due to rounding. Blanks within the table indicate that no observations were made.

[1] Mule deer were not sighted in other habitat types (table III-8).

Other Big Game Animals

Although no moose were observed, tracks and pellets indicated that moose inhabited lodgepole pine and willow habitats along Clancy Creek and Kady Gulch. During July 1984, black bears were observed on five occasions in the study area (figure III-10). Three sightings were in the Douglas-fir/grass type; two were in the grassland type. Bear tracks and droppings were occasionally recorded in forested western portions of the study area.

Other Mammals

Coyotes are considered common in the study area; 12 observations were made during the baseline survey (figure III-10). Observations and tracks revealed that coyotes range throughout all habitat types. Two dens--one active and one inactive--were located. Other mammal species (observed or indicated by sign) that inhabit the study area include beaver, snowshoe hare, Columbian ground squirrel, porcupine, long-tailed weasel, red squirrel, and golden-mantled ground squirrel.

Traps were set to sample small mammal populations. Only deer mice were caught. Overall trapping success was low with most mice captured in the bitterbrush/grass type.

Raptors (Birds of Prey)

Ten raptorial species were recorded in the study area. Red-tailed hawks were observed eight times from May through September. In the fall, red-tails left the area and were replaced by migrating rough-legged hawks. Golden eagles were seen only eight times and none were seen in winter. A single bald eagle, a federally listed endangered species, was recorded soaring over the area on October 25, 1984.

Goshawks and Cooper's hawks were occasionally observed in forested habitats. American kestrels, the most frequently observed raptor, probably nested in the forested habitats. However, no nest of kestrels nor nests of any other raptors could be located. During searches for nests, screech owls and saw-whet owls were sighted. A lone pygmy owl, probably a migrant, was also observed.

Songbirds and Gamebirds

A census was taken of songbirds along transects distributed throughout the study area. The list of species observed grew from 21 in April to 42 in June. Flycatchers, thrushes, and warblers accounted for most of this increase. The number of species declined in August as species migrated out of the area. By winter, only a few year-round residents (such as mountain chickadee, dark-eyed junco, and red-breasted nuthatch) and winter migrants (such as rough-legged hawk) inhabited the study area.

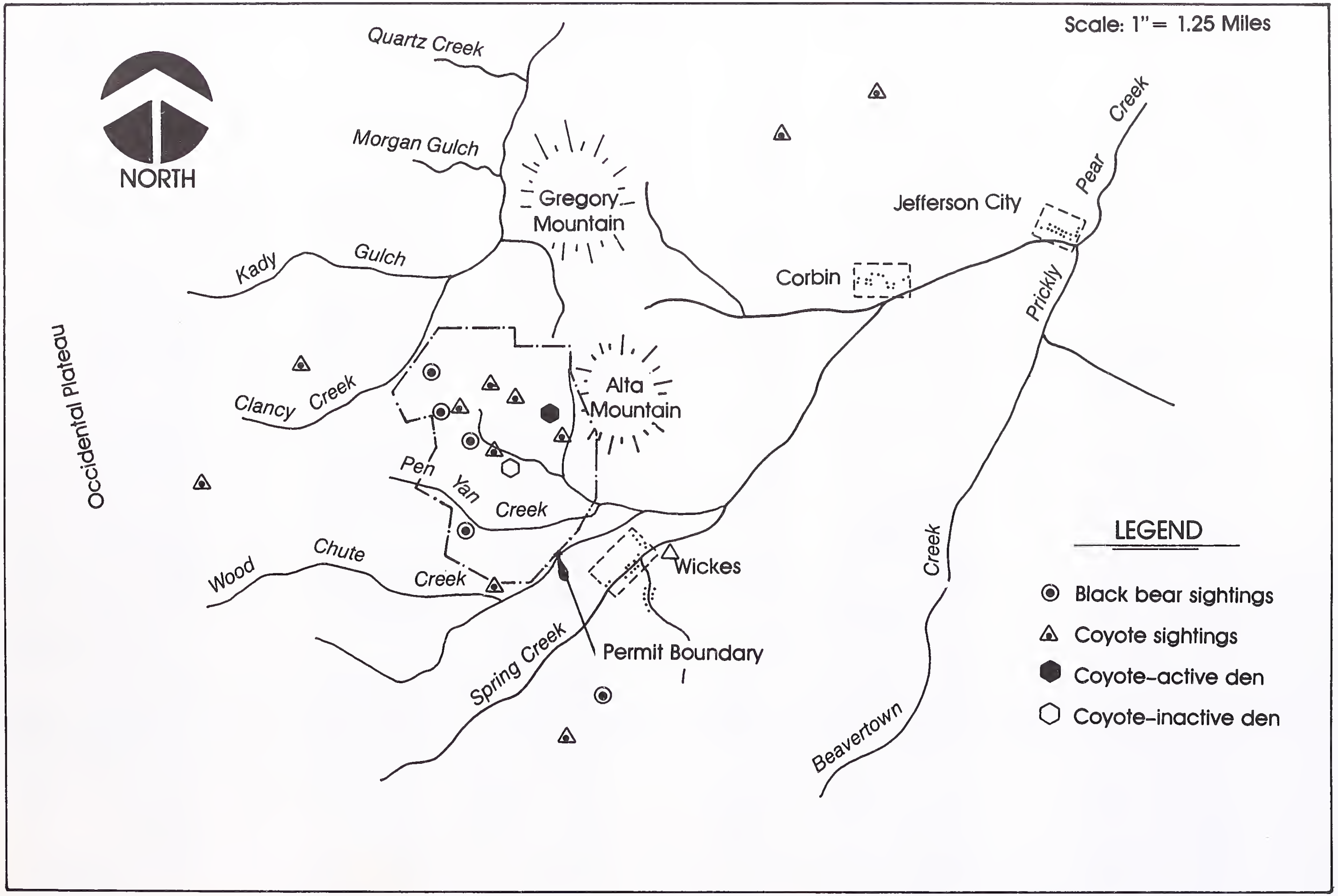

Figure III-10
Four black bear observations were made in the proposed permit area. The other commonly observed carnivore was the coyote.

Forested areas provided habitats for ruby-crowned kinglets, robins, dark-eyed juncos, and mountain chickadees. Horned larks, western meadowlarks, vesper sparrows, and lark sparrows lived in grassland habitats. Grassland habitats usually supported the greatest number of individuals. Forested habitats, especially the Douglas-fir/grass type, contained the more diverse bird populations (figure III-11).

The only gamebirds found were the ruffed grouse and the blue grouse. Ruffed grouse were considered common (12 observations of 24 individuals) in willow and aspen habitats. Blue grouse were seen occasionally (5 observations) in Douglas-fir forests. Sounds produced by courting grouse were heard on 12 occasions.

CLIMATE

The climate of the project area is modified continental. The main modifiers are Pacific Ocean air masses, drainage of cool air from the surrounding mountains, and the protecting mountain shield in all directions. These modifiers make temperature changes somewhat smaller than those expected of a true continental climate.

Precipitation varies from about 10 to 30 inches per year in the general area due to the influence of the mountains. The project area itself would be more typical of the subarid classification due to the proximity of the mountains with average precipitation of about 15 inches per year. The majority of the precipitation falls in the spring and summer months.

Temperatures in the area are moderate. Temperatures during the summer months are generally in the low 50s at night and under 90 degrees F during the day. High temperatures seldom exceed 100 degrees F. Winter temperature extremes are usually near 10 degrees F at night and warm to near 32 degrees F at mid-day. Occasional low temperatures around -30 degrees F may occur.

Prevailing winds occur from the northwest during most months, and less frequently from the southeast. The average wind speed measured during the baseline monitoring program was 6.4 miles per hour. (Wind speed and direction were monitored at the upper air quality monitoring site (see Chapter III--Air Quality). Strongest average winds occurred in the spring with the lowest average wind speeds in the autumn.

The project area, as with other valleys in western Montana, is ideal for the formation of strong and persistent temperature inversions. During an inversion, wind speeds are very low and there is little air mixing a situation, which tends to trap air pollutants. Temperature inversions are most common in the fall and winter months, but do occur in the spring and summer as well.

AIR QUALITY

The air quality at the proposed project site is very good. Total suspended particulate (TSP) was monitored at two sites in the immediate area. The

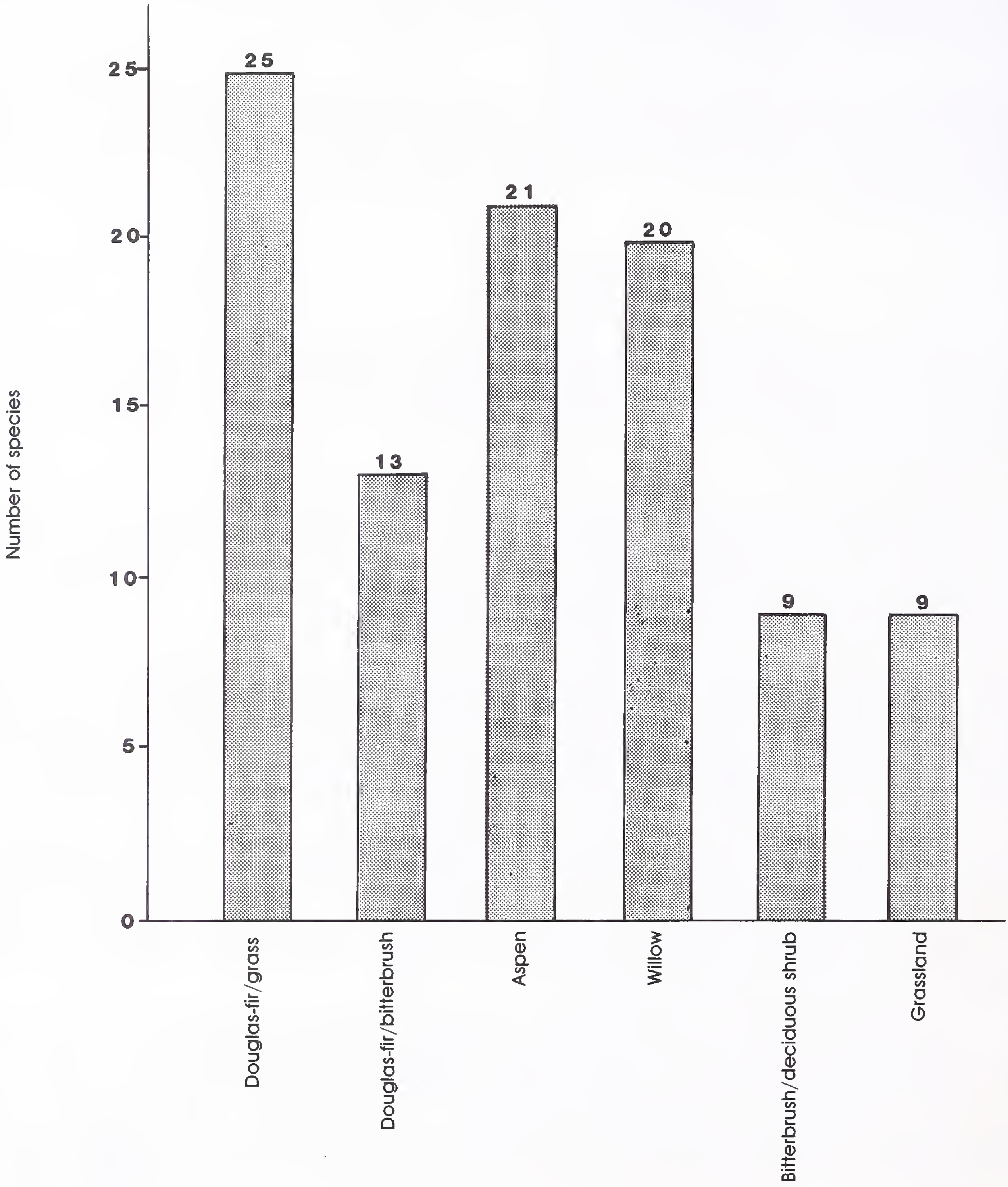

Figure III-11

Wooded habitats contained more diverse bird populations than did open habitats.

upper site was in the proposed pit area and the lower site was located at the southeast corner of the proposed tailings impoundment. Annual average TSP concentrations at the upper and lower sites were 9.6 micrograms per cubic meter ($\mu g/m^3$) and 11.7 $\mu g/m^3$. Maximum 24-hour TSP concentrations measured were 41 $\mu g/m^3$ at the upper site and 61 $\mu g/m^3$ at the lower site. Monitoring at the upper site was limited to summer months due to weather-related access constraints; monitoring at the lower site was performed from June 1984 through May 1985. The measured levels are well below Montana and federal ambient air quality standards for TSP (table III-11) and considered typical of background conditions for western Montana (Montana Department of Health and Environmental Sciences, 1985a).

Sample filters from the monitoring program were analyzed for trace-element concentrations. Lead concentrations were well below ambient standards. Other trace elements monitored were also low, generally near or below detection limits.

In the Corbin area there is a local air pollution problem related to wind erosion of old tailings deposits. These tailings are located along Spring Creek at Corbin and downstream for about three quarters of a mile. These tailings have high trace-element concentrations, particularly of lead and arsenic. Due to the fine-grained texture of the tailings, some of the material becomes airborne during windy conditions. A recent air quality study of the area indicates that impact to Corbin and Jefferson City is minimal; however, particulate and trace-element concentrations on the tailings are quite high (MDSL, 1985).

There are no other significant sources of particulate or gaseous emissions in the general area of the project. Existing minor sources include vehicle traffic, home heating, and mine exploration activities.

EMPLOYMENT

Jefferson County

The major employment sector in the Jefferson County economy is state and local government, accounting for 37 percent of total employment in 1982 (see table III-12). Boulder River School and Hospital (BRSH), established in 1894, is the single largest government employer in the county, with 440.5 authorized full-time equivalent (FTE) positions and 429 current employees (source: Sharon Bullock, administrative secretary, BRSH, pers. comm., October 7, 1985). BRSH is the primary state facility for care and treatment of the developmentally disabled (Mountain International, 1984, p. 31).

In recent years, mining has re-emerged as an important sector of the Jefferson County economy. In 1963, the Kaiser Cement plant opened in Montana City, employing 90 workers. In 1982, Golden Sunlight, an open-pit gold mine with an estimated 13-year life, came on line. The mine employs about 142 workers (Jim Smolick, Golden Sunlight Mine, pers. comm., October 7, 1985). Mine employment accounted for almost 3 percent of total county employment in 1982 and has more than doubled between 1977 to 1982. Mine employment almost tripled between 1982 and 1983 to a level of 151, largely due to the opening of the Golden Sunlight Mine (see table III-12).

Table III-11: Montana and National Air Quality Standards

Pollutant	Montana standard	Federal primary standard	Federal secondary standard
Total suspended particulates	75 $\mu g/m^3$ annual average 200 $\mu g/m^3$ 24-hr average*	75 $\mu g/m^3$ annual geometric mean 260 $\mu g/m^3$ 24-hr average*	60 $\mu g/m^3$ annual geometric mean 150 $\mu g/m^3$ 24-hr average*
Sulfur dioxide	0.02 ppm annual average 0.10 ppm 24-hr average* 0.50 ppm 1-hr average**	0.03 ppm annual average 0.14 ppm 24-hr average*	0.5 ppm 3-hr average*
Carbon monoxide	9 ppm 8-hr average* 23 ppm hourly average*	9 ppm 8-hr average* 35 ppm 1-hr average*	9 ppm 8-hr average*
Nitrogen dioxide	0.05 ppm annual average 0.30 ppm 1-hr average*	0.05 ppm annual average	0.05 ppm annual average
Photochemical oxidants (ozone)	0.10 hourly average*	0.12 ppm 1-hr average*	0.12 ppm 1-hr average*
Lead	1.5 $\mu g/m^3$ 90-day average	1.5 $\mu g/m^3$ calendar quarter average	None
Settled particulate (dustfall)	10 mg/m^2 30-day average	None	None

Source: DSL working papers, 1985.

*Not to be exceeded more than once per year.

$\mu g/m^3$ micrograms pollutant per cubic meter of sampled air.

ppm parts pollutant per million parts of sampled air.

**Not to be exceeded more than 18 times per year.

Table III-12: Jefferson County Employment

Employment by place of work	1970	1972	1977	1978	1979	1980	1981	1982	Percentage of total 1978	Percentage of total 1982	Percentage change 78-82
Total employment	1,813	1,800	1,888	1,899	1,880	1,912	1,927	2,124	100	100	11.8
Employment by place of work											
Wage and salary employment	1,415	1,383	1,447	1,422	1,385	1,401	1,409	1,662	74.9	78.2	16.9
Proprietors' employment	398	417	441	477	495	511	518	528	25.1	24.9	10.7
Farm	208	192	169	169	169	169	170	170	8.9	8.0	0.6
Nonfarm	190	225	272	308	326	342	348	358	16.2	16.9	16.2
Wage and salary employment by industry											
Farm	61	63	46	47	56	54	54	54	2.5	2.5	14.9
Nonfarm	1,354	1,320	1,401	1,375	1,329	1,347	1,355	1,542	72.4	72.6	12.1
Private	426	419	498	483	466	522	547	666	25.4	31.4	37.9
Agricultural services, forestry, fisheries, and other	(L)	(L)	10	(D)	17	(D)	(D)	(D)	0.0	0.0	0.0
Mining	23	(L)	18	15	17	70	79	56	0.8	2.6	273.3
Construction	29	38	36	57	45	48	34	166	3.0	7.8	191.2
Manufacturing	16	18	45	40	34	23	23	19	2.1	0.9	-52.5
Non-durable goods	0	0	0	0	0	0	0	0	0.0	0	0.0
Durable goods	14	18	45	40	34	23	23	19	2.1	0.9	-52.5
Transportation and public utilities	(D)	(D)	34	(D)	36	(D)	(D)	(D)	0.0	0.0	0.0
Wholesale trade	(L)	(L)	12	10	14	19	13	11	0.5	0.5	10.0
Retail trade	108	108	103	149	129	106	123	138	7.8	6.5	-7.4
Finance, insurance, and real estate	20	27	25	30	32	34	39	36	1.6	1.7	20.0
Services	(D)	(D)	215	(D)	142	167	179	182	0.0	8.6	0.0
Government and government enterprises	928	901	903	892	863	825	808	876	47.0	41.2	-1.8
Federal, civilian	94	73	54	56	67	59	61	57	2.9	2.7	1.8
Federal, military	45	53	41	43	44	42	34	32	2.3	1.5	-25.6
State and local	789	775	808	793	752	724	713	787	41.8	37.1	-0.8

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information File, Table 25.00, April 1984.

[1] Employment estimates for 1976-1982 are based on 1972 Standard Industrial Codes. Estimates of 1970 employment are based on 1967 Standard Industrial Codes.

(L) This symbol indicates less than 10 jobs; however, the number is included in totals.

(D) Indicates that information is excluded to avoid disclosure of confidential data.

After state and local government, proprietors', service, and retail trade employment are the largest sectors in the Jefferson economy. Following state trends, employment in agriculture has declined over the years. Construction employment, although showing a large increase between 1981 and 1982, will not likely sustain its current level without new projects. The reconstruction of I-15 around Basin is near completion and the Golden Sunlight Mine is in production.

The percentage of unemployed workers in Jefferson County has been consistently above the statewide average and the average for Lewis and Clark County (see table III-13). Unemployment peaked in 1983 at 11.2 percent, when the state began to recover from the most recent nationwide recession. Unemployment rates are still above those in the late 1970s.

The Jefferson County economy has benefitted from its close proximity to Helena, which has provided a source of employment for residents of Jefferson County. In 1980, an estimated 826 Jefferson County residents (about 30 percent of all employed county residents) worked in Lewis and Clark County (U.S. Census, 1980, in project application, volume IV, p. 127). Additionally, many Helena employees left Lewis and Clark County and settled in the Montana City and Clancy area in northern Jefferson County. Since the mid-1960s, the population of northern Jefferson County has increased from 1,115 to 2,453 and this growth has accounted for more than 70 percent of the county population increase since 1970 (project application, 1984, volume IV, p. 33).

However, the Jefferson County economy is also at a disadvantage due to the proximity of Helena. The larger, more metropolitan area captures much of the Jefferson County trade. Therefore, employment gains in Jefferson County, although providing new consumer income to the county, will largely benefit the retail trade and service businesses of the Helena area.

Employment in Jefferson County is forecast to sustain a slow, modest growth rate. If Golden Sunlight ceases operations in 1996, as originally planned, county employment will experience a moderate decline; however, the impact will be much more severe in the Whitehall area near the mine. If employment at the BRSH is cut back, county employment will also decline.

Total Jefferson County employment has remained relatively steady--increasing an average 1.1 percent annually between 1967 and 1982. Although annual growth rates have been higher recently--averaging 1.7 from 1972 to 1982 and 2.4 between 1977 and 1982--smaller annual increases are projected over the next 15 years.

Table III-14 shows the projected total county employment through 2000. The forecast assumes that county employment will grow at its historic rate of 1.1 percent annually. However, between 1995 and 2000, when Golden Sunlight is expected to close, employment will decline. Employment at the BRSH is projected to remain constant. If employment reductions were instituted at BRSH, impacts to the county economy would depend on the level of reduction. The 1985 legislature did not enforce work force cuts recommended in a study by the HB909 Advisory Council. However, if such cuts were made (patient load reduced to 60 and staff reduced to 116), total county employment could drop by 268 to 417 jobs (project application, volume IV, p. 128).

Table III-13: Historical Unemployment in the Study Area and State (in percentage)

Year	Jefferson County	Lewis and Clark County	Montana
1976	7.6	4.6	6.1
1977	7.9	5.0	6.4
1978	7.9	5.6	6.2
1979	7.4	4.8	5.1
1980	6.5	5.0	6.1
1981	7.5	5.8	6.9
1982	10.4	7.2	8.6
1983	11.2	7.2	8.8
1984	8.4	6.2	7.8
1985	8.9	6.4	7.8

Source: Montana Department of Labor and Industry, Research and Analysis Bureau, Montana Employment and Labor Force Quarterly Report, first quarter 1985, pp. 11-13 and pp. 27-36, and second quarter 1985, pp. 15-17.
Note: 1985 data is preliminary and covers the first two quarters only. The annual 1985 rate may vary from those listed in this table.

Table III-14: Baseline Employment Forecast for Jefferson County

Employment	1985	1990	1995	2000
Total employment	2,195 - 2,219	2,241 - 2,319	2,295 - 2,450	2,362 - 2,589
Basic	1,315 - 1,329	1,311 - 1,357	1,313 - 1,433	1,318 - 1,444
Nonbasic	880 - 890	930 - 962	982 - 1,017	1,044 - 1,145

Source: Project application, volume IV, p. 115 and DSL working papers, September 17, 1985.

Note that the categories of employment show total, basic, and nonbasic employment. Basic employment refers to jobs in businesses whose products or services are purchased by persons from outside Jefferson County. Examples of such export-based or basic employment include agriculture, mining, federal government employment, and tourist-purchased services and retail trade. Basic sector employment brings in "new" income, a part of which is spent in the local economy and fosters new additional jobs. Such induced employment is called nonbasic employment. The ratio of basic to nonbasic employment forms the employment multiplier used to predict the increase or decrease in nonbasic employment as a result of growth or decline in basic employment.

The employment multiplier for Jefferson County is between 0.25 to 0.3, which is representative of small, rural economies. The multiplier means that for every new basic job created in the county, one-quarter to one-third new nonbasic job will be created. It takes 3 to 4 new basic industry jobs to induce one additional nonbasic job. Such multipliers are typical for areas with large trade leakages to other, more developed economies. There is a time lag between basic employment gains and induced increases in nonbasic jobs; such lags can range from one to four years.

The employment forecast for Jefferson County shows a high and low range of employment. The high forecast assumes an employment multiplier of 0.3, a one-year lag in nonbasic job creation, and an average annual growth of 1.105 percent. The low employment forecast is drawn from the project application.

Lewis and Clark County

Like Jefferson County, the major employer in Lewis and Clark County is the government sector. Total government employment in Helena, the capital city, is almost one-third of all employment, with state and local government providing nearly one-quarter of all jobs (see table III-15).

State government employment in Helena grew rapidly from the 1960s to its peak in 1980, increasing more than 70 percent. However, since 1980, state and local government employment in the county has decreased more than 5 percent (see table III-15).

Federal employment has remained nearly constant, hovering around 1,550 over the last 10 years. Such stability is due in large part to the Fort Harrison Veteran's Administration Hospital, and the National Guard and Army Reserve, which are the main federal employers.

Service and retail trade are the other major employers in the county accounting for 20 and 15 percent of total employment. Job gains in these two sectors have offset declines in the state and local government sectors, and have been the main contributors to the modest growth in total employment over the last five years.

The number of jobs in the transportation and public utilities sector grew 71 percent from 1970 to its peak in 1980. However, since that point, employment has fallen 7 percent, largely due to the regional reorganization of Mountain Bell. In spite of such employment cutbacks, the sector comprised almost eight percent of total county employment in 1982.

The number of agricultural jobs has declined steadily from the early 1960s, mirroring the statewide trend. Total agricultural proprietor and wage and salary employment accounted for less than 1.5 percent of all county jobs in 1982.

Over the last 15 years, Lewis and Clark County employment increased about 1.03 percent annually. Annual growth rates over the last 10 years were 1.03 percent; the past 5 years were at 1.01 percent. The county and Helena-area economies show little growth, maintaining employment levels achieved in the late 1970s.

Table III-15: Lewis and Clark County Employment

Sector of employment	1970	1972	1977	1978	1979	1980	1981	1982	Percentage of total 1977	Percentage of total 1982	Percentage change 77-82
Total employment	16,452	17,703	21,983	22,948	23,378	23,526	23,609	23,167	100.0	100.0	5.4
Employment by place of work											
Wage and salary employment	14,820	16,116	20,007	20,790	21,133	21,253	21,299	20,801	91.0	89.8	4.0
Proprietors' employment	1,632	1,587	1,976	2,158	2,245	2,273	2,310	2,366	9.0	10.2	19.7
Farm	367	323	269	268	268	268	268	268	1.2	1.2	-0.4
Nonfarm	1,265	1,264	1,707	1,890	1,977	2,005	2,042	2,098	7.8	9.1	22.9
Wage and salary employment by industry											
Farm	201	228	181	183	217	206	206	204	0.8	0.9	12.7
Nonfarm	14,619	15,888	19,826	20,607	20,916	21,047	21,093	20,597	90.2	88.9	3.9
Private	9,202	10,142	12,810	13,471	13,592	13,685	13,843	13,646	58.3	58.9	6.5
Agricultural services, forestry, fisheries, and other	21	25	41	48	39	36	38	44	0.2	0.2	7.3
Mining	20	11	28	27	30	69	54	44	0.1	0.2	57.1
Construction	794	701	841	838	727	635	692	559	3.8	2.4	-33.5
Manufacturing	983	892	1,120	1,147	1,131	1,190	1,173	1,159	5.1	5.0	3.5
Non-durable goods	386	327	433	440	424	413	473	470	2.0	2.0	8.5
Durable goods	597	565	687	707	707	777	700	689	3.1	3.0	0.3
Transportation and public utilities	1,119	1,094	1,540	1,658	1,877	1,917	1,856	1,778	7.0	7.7	15.5
Wholesale trade	328	459	624	652	703	700	681	689	2.8	3.0	10.4
Retail trade	1,982	2,219	3,218	3,271	3,269	3,211	3,396	3,419	14.6	14.8	6.2
Finance, insurance, and real estate	922	1,026	1,280	1,383	1,443	1,458	1,407	1,343	5.8	5.8	4.9
Services	3,033	3,715	4,118	4,447	4,373	4,469	4,546	4,611	18.7	19.9	12.0
Government and government enterprises	5,417	5,746	7,016	7,136	7,324	7,362	7,250	6,951	31.9	30.0	-0.9
Federal, civilian	1,037	1,087	1,219	1,278	1,246	1,279	1,270	1,245	5.5	5.4	2.1
Federal, military	301	315	258	263	277	280	228	214	1.2	0.9	-17.1
State and local	4,079	4,344	5,539	5,595	5,801	5,803	5,756	5,492	25.2	23.7	-0.8

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System, Table 25.00, April 1984.

Table III-13 showed annual unemployment rates over the last 10 years for Jefferson and Lewis and Clark counties and the state. Lewis and Clark County has had lower rates of unemployment than either the state or Jefferson County. State and federal government employment provide the stability for Lewis and Clark County. However, during the recent recession, unemployment climbed more than one percent from 1981 to 1982.

Estimated employment in Lewis and Clark County without the project is expected to post small gains through the year 2000 (see table III-16). Unless an unforeseen decrease in state or federal government employment occurs, future growth rates are expected to be consistent with historic levels.

The ratio of basic to nonbasic employment is higher in Lewis and Clark County than that of Jefferson County. Because Lewis and Clark County has more basic employment and draws from a larger trade area, the ratio of basic to nonbasic employment is estimated to range from 0.85 to 1.00. In other words, each new basic job creates 0.85 to 1.00 additional nonbasic job.

The low-employment estimate assumes that county employment continues to increase about 1 percent annually, the ratio of basic to nonbasic employment is 1.0 to 1.0, and the time lag for nonbasic job creation is 1 year. The high-range forecast is drawn from the project application. If there are significant, unanticipated declines in government employment, these forecasts will be too high.

INCOME

Jefferson County

Jefferson County residents, on average, have a lower per capita income than either Lewis and Clark County or Montana residents in general. Table III-17 shows real (inflation adjusted) per capita incomes for both counties and the state. Jefferson County per capita income has ranged from almost 70 percent of the state average to a high of 90 percent in 1982. The 1983 average was slightly lower at 85.9 percent. However, between 1971 and 1981, real, inflation-adjusted income growth in the county was above the statewide average, and the total county increase was almost twice the state increase. Such increases in real income could be attributable in part to the growth in the number of residents of northern Jefferson County who work in Lewis and Clark County.

In 1979, the mean income of Jefferson County households was $18,765, about four percent higher than the statewide average of $17,994 (U.S. Department of Commerce, 1983). However, family sizes are larger on average in Jefferson County (3.35) compared to the state (3.24), which could account for the seemingly contradictory statistics of lower per capita yet higher household income in the county as compared to the statewide average.

Table III-18 shows historic, inflation-adjusted personal income in Jefferson County by industry. Total county income has grown over the last 20 years--almost 62 percent. Over the most recent five years, total real income

Table III-16: Lewis and Clark County Employment Forecast

Employment	1985	1990	1995	2000
Total employment	23,983 - 25,114	25,195 - 25,428	26,552 - 26,911	27,983 - 28,432
Basic	10,668 - 11,170	11,206 - 11,310	11,811 - 11,971	12,447 - 12,647
Nonbasic	13,315 - 13,944	13,989 - 14,118	14,741 - 14,940	15,536 - 15,785

Source: Project application, volume IV, p. 120, and DSL working papers, September 17, 1985.

Table III-17: Real Per Capita Income for Jefferson and Lewis and Clark Counties and Montana[1] (1980 dollars)

Jurisdiction	1962	1973	1978	1979	1980	1981	1982	1983
Jefferson County	$4,662	$5,643	$6,945	$7,182	$7,398	$7,385	$7,532	$7,159
Percentage of state average	83.7	69.8	82.6	85.4	88.8	86.7	90.1	85.9
Lewis and Clark County	$6,306	$8,577	$9,729	$9,524	$9,468	$9,526	$9,574	$9,687
Percentage of state average	113.2	106.2	115.7	113.3	113.6	114.3	114.6	116.2
Montana average	$5,569	$8,080	$8,409	$8,311	$8,334	$8,516	$8,357	$8,334

Source: U.S. Department of Commerce, Bureau of the Census, Regional Economic Information System, annual estimates.

[1] Income figures were deflated or inflated using implicit price deflators for personal consumption expenditures published in July issues of The Survey of Current Business.

continued to grow about 3 percent annually, in spite of the severe recession in the early 1980s. Earnings by industry (table III-18) show that the largest growth occurred in wages and salaries in the private sector, led by mining, construction, and agricultural services, forestry, and fisheries industries. The major boost in mining-sector income was due to the opening of the Golden Sunlight Mine, which accounted for a 300-percent increase between 1982 and 1983. Earnings in the construction industry increased six fold between 1981 and 1982, largely due to the reconstruction of I-15 near Basin. However, earnings fell almost 50 percent between 1982 and 1983 and will likely decrease even further in 1985 and 1986 as the I-15 project is completed.

Strong growth was evident in unearned income--transfer payments (for example, social security, workers' compensation, and welfare payments) and payments for dividends, interest, and rent. Unearned income grew more than 200 percent between 1973 and 1983, slightly over 7 percent annually above the rate of inflation. Unearned income accounted for over one-third of total county income in 1983, compared to 27 percent in 1973.

Table III-18: Jefferson County Personal Income by Source (thousands of 1980 dollars)

Income by type	1962	1973	1978	1979
Total personal income	$ 16,873	$ 35,208	$ 49,121	$ 51,973
Nonfarm personal income	14,478	31,496	45,743	48,589
Farm income	2,395	3,712	3,378	3,384
Total earnings by place of work	14,322	19,680	21,001	19,875
Components of earnings				
Wages and salaries	10,353	14,193	15,220	14,663
Other labor income	241	660	822	790
Proprietors' income	3,728	4,827	4,958	4,423
Farm	2,374	3,057	2,375	2,207
Nonfarm	1,355	1,770	2,584	2,215
Earnings by industry				
Farm	2,880	3,712	3,378	3,384
Nonfarm	11,443	15,967	17,623	16,491
Private	5,319	6,592	7,198	6,707
Agricultural services, forestry, fisheries, and other	(L)	(D)	(D)	99
Mining	(L)	(D)	265	432
Construction	1,094	1,116	1,624	1,234
Manufacturing	136	390	581	458
Non-durable goods	(L)	0	0	0
Durable goods	(L)	390	581	458
Transportation and public utilities	(D)	1,983	(D)	999
Wholesale trade	(L)	(D)	164	180
Retail trade	1,138	1,318	1,529	1,331
Finance, insurance, and real estate	158	363	522	506
Services	(D)	1,210	(D)	1 ,469
Gov't and gov't enterprises	6,124	9,376	10,424	9,784
Federal, civilian	849	1,135	849	870
Federal, military	(L)	141	121	122
State and local	5,205	8,100	9,454	8,791
Population (in thousands)	4.4	6.2	7.1	7.2
Per capita personal income (dollars)	4,662	5,643	6,945	7,182
Derivation of total personal income				
Total earnings by place of work	14,322	19,680	21,001	19,875
Less: personal contribution for social insurance	508	1,013	1,196	1,150
Plus: residence adjustment	2,096	6,885	15,188	17,598
Equals: net earnings by place of residence	15,911	25,552	34,993	36,323
Plus: dividends, interest and rent	2,160	4,142	6,685	8,069
Plus: transfer payments	2,218	5,514	7,443	7,581

Source: U.S. Department of Commerce, Bureau of the Census, Regional Economic Information System,
1929-1974 data are based on 1967 standard industrial codes while 1975-1983 data are based on 1972
(L) means less than $50,000. (D) means data not shown to avoid disclosure of confidential
expenditures published in annual July issues of The Survey of Current Business.
N/A means not applicable.

1980	1981	1982	1983	Annual rate of change 10 years	Annual rate of change 5 years
$ 52,036	$ 53,357	$ 54,848	$ 57,160	4.97	3.08
49,238	50,940	52,788	55,477	5.82	3.93
2,798	2,417	2,060	1,683	-7.61	-13.00
19,259	18,990	24,001	24,501	1.55	4.27
14,971	15,377	20,827	20,942	3.24	7.39
927	1,080	1,469	1,916	8.82	19.39
3,361	2,533	1,705	1,643	-10.46	-17.96
0	1,383	925	606	-12.77	-22.79
1,719	1,149	779	1,037	-8.72	-14.08
2,798	2,417	2,060	1,683	-6.73	13.04
16,461	16,573	21,941	22,818	2.62	6.71
7,001	7,145	11,216	11,549	4.84	11.48
(D)	(D)	(D)	208	N/A	15.96
1,359	1,436	1,175	3,695	30.13	53.62
1,066	721	4,936	2,391	3.94	14.15
296	265	196	218	-9.34	-13.82
0	0	0	0	N/A	N/A
296	265	196	218	-9.34	-13.82
(D)	(D)	(D)	1,712	N/A	11.37
202	186	156	127	-2.52	-6.64
1,109	937	1,002	1,294	-1.66	-0.60
453	418	433	463	-1.19	-1.73
1,526	1,536	1,527	1,441	N/A	-0.4
9,460	9,428	10,724	11,270	0.78	2.87
831	899	851	862	0.16	-0.20
121	108	113	144	1.74	3.35
8,508	8,421	9,761	10,263	0.82	3.14
7	7.2	7.3	8	1.20	2.13
7,398	7,385	7,532	7,159	0.30	-0.60
19,259	18,990	24,001	24,501	1.55	4.27
1,163	1,226	1,641	1,685	3.49	7.94
17,386	17,426	12,625	14,069	-0.76	-4.38
35,482	35,190	34,985	36,885	0.53	0.31
8,576	9,892	10,713	10,649	4.77	5.71
7,978	8,274	9,150	9,625	2.60	4.89

annual estimates.

standard industrial codes.

information. Values were deflated using the implicit price deflator for personal consumption

Earnings in the federal, state, and local government sector have risen since 1978, with most of the increase from 1981 to 1983. Total government income made up more than one-fifth of total county income in 1983, slightly more than the statewide average of 15 percent.

The category called residence adjustment measures income that county residents were paid from jobs in other counties. In 1983, Jefferson County residents earned almost one-fourth of total personal income in jobs outside the county down from 38 percent in 1979. The residence adjustment to total county income peaked in 1979 and has declined almost 25 percent since then, mirroring the trend of total earned income in Lewis and Clark County.

Farm income in Jefferson County has fallen dramatically over the last two decades. Since 1962, farm proprietors' income has decreased almost 75 percent. Total income in the farm sector declined also over the same period--42 percent.

The recession has affected nonfarm proprietors' earnings as well, which reached a low point in 1982. Between the peak in 1978 and the trough in 1982, nonfarm proprietors' income fell over 70 percent. However, earnings improved from 1982 to 1983.

Jefferson County Income Without the Project

Real total personal income is forecast to increase over $20 million between 1985 and 2000 (see table III-19). The largest annual increases are expected between 1983 and 1985, as the county economy gains strength after the recession. Statewide recovery has lagged gains in employment and income nationwide (Economics Montana, 1985). While Montana had yet to reach pre-recession peak levels of personal income and employment in mid-1985, the United States had fully recovered in 1983.

Jefferson County personal income is predicted to have increased about 4 percent annually until 1985. Between 1985 and 2000, real income growth (above inflation) is forecast to grow 2 percent annually due to gains in employment and moderate increases in real wages.

Table III-19: Total Personal Income Baseline Forecast (thousands of 1980 dollars)

Income	1985	1990	1995	2000
Jefferson County				
Total personal income	$62,181	$68,653	$75,798	$83,687
Lewis and Clark County				
Total personal income	$512,880	$580,277	$656,530	$742,803

Lewis and Clark County

The Lewis and Clark County economy enjoys a high degree of stability due to federal, state, and local government employment. Table III-17 shows annual real per capita incomes for the county compared to statewide and Jefferson County averages. Over the last 10 years, Lewis and Clark County per capita income has ranged from 6.2 to 16.2 percent higher than the state average. Some of the difference can be accounted for by the higher labor force participation rates in Lewis and Clark County than statewide, particularly among women, due to government employment opportunities. In addition, the farm sector is less important to county earnings than to state income.

Over the last 20 years, per capita and county income increased about 54 percent compared to about 50 percent for the state, while income growth over the last 10 years was 12.9 percent for the county and 3.1 percent for the state. However, county per capita income peaked in 1978 and had not regained that level as of 1983.

Annual changes in Lewis and Clark County real personal income were generally above those for the state (see table III-20). However, such changes were below those reported for Jefferson County except in 1977. The total increase in real Lewis and Clark County personal income was slightly over half that measured in Jefferson County.

Table III-21 shows Lewis and Clark County personal income for selected years and adjusted for inflation. Over the past 20 years, total county income increased about 285 percent. Income growth slowed between 1978 and 1983, however, due in large part to the severe recession in the early 1980s. Many of

Table III-20: Annual Change in Real Inflation-Adjusted Income for Jefferson and Lewis and Clark Counties and Montana

Year	Jefferson County	Lewis and Clark County	Montana
1971	5.3	4.6	0.9
1975	2.7	6.2	0.6
1976	10.0	9.6	2.4
1977	6.7	7.2	2.8
1978	9.9	5.0	9.1
1979	5.1	0.5	-0.4
1980	1.7	1.7	-0.1
1981	3.3	3.0	3.5
Total change from 1971 to 1981	98.5	54.5	47.2

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Information System, magnetic tapes.

Table III-21: Lewis and Clark County Personal Income by Source (thousands of 1980 dollars)

Income by type	1962	1973	1978	1979
Total personal income	$152,971	$309,665	$405,594	$404,969
Nonfarm personal income	146,738	299,889	401,803	401,620
Farm income	6,233	9,776	3,791	3,349
Total earnings by place of work	147,933	254,294	334,573	327,160
Components of earnings				
Wages and salaries	120,322	210,302	277,213	276,990
Other labor income	3,682	13,124	23,498	23,240
Proprietors' income	23,929	30,868	33,861	26,930
Farm	5,112	7,236	1,445	604
Nonfarm	18,817	23,631	32,416	26,327
Earnings by industry				
Farm	7,496	9,776	3,791	3,349
Nonfarm	140,437	244,517	330,781	323,812
Private	95,882	156,887	219,618	212,416
Agricultural services, forestry, fisheries, and other	(L)	(D)	529	343
Mining	255	(D)	498	641
Construction	13,846	16,952	23,545	18,929
Manufacturing	12,498	17,995	24,037	24,237
Non-durable goods	3,955	6,032	7,204	7,023
Durable goods	8,544	11,963	16,833	17,214
Transportation and public utilities	7,603	24,403	41,189	43,124
Wholesale trade	5,672	8,556	13,836	14,311
Retail trade	16,740	25,900	31,931	31,504
Finance, insurance, and real estate	11,477	16,527	23,124	23,495
Services	27,694	46,277	60,928	55,833
Gov't and gov't enterprises	44,555	87,630	111,164	111,395
Federal, civilian	16,032	23,864	26,830	26,027
Federal, military	564	1,079	916	1,111
State and local	27,959	62,687	83,418	84,257
Population (in thousands)	29.2	36.1	41.7	42.5
Per capita personal income (dollars)	6,306	8,577	9,729	9,529
Derivation of total personal income				
Total earnings by place of work	147,933	254,294	334,573	327,160
Less: personal contribution for social insurance	5,552	14,912	21,440	21,812
Plus: residence adjustment	(1,360)	(6,225)	(15,491)	(15,467)
Equals: net earnings by place of residence	141,021	233,156	297,642	289,882
Plus: dividends, interest and rent	27,923	39,767	55,065	60,143
Plus: transfer payments	14,996	36,742	52,887	54,944

Source: U.S. Department of Commerce, Bureau of the Census, Regional Economic Information System, 1929-1974 data are based on 1967 standard industrial codes while 1975-1983 data are based on 1972 (L) means less than $50,000. (D) means data not shown to avoid disclosure of confidential expenditures published in annual July issues of The Survey of Current Business.
N/A means not applicable.

1980	1981	1982	1983	Annual rate of change 10 years	Annual rate of change 5 years
$409,959	$418,557	$424,701	$436,473	3.49	1.48
406,659	415,107	421,556	433,830	3.76	1.55
3,300	3,450	3,145	2,643	-14.00	-7.02
325,851	322,518	316,733	326,677	2.54	-0.48
280,564	282,835	279,464	285,823	3.12	0.61
25,265	24,258	26,438	28,121	7.92	3.66
21,022	15,424	10,830	12,732	-8.48	-17.78
605	1,031	493	112	-34.07	-40.01
20,417	14,394	10,338	12,620	-6.08	-17.19
3,300	3,450	3,145	2,643	-12.26	-6.96
322,551	319,067	313,588	324,034	2.86	-0.41
212,027	207,291	201,735	205,411	2.73	-1.13
266	252	273	297	N/A	-10.94
1,407	940	720	1,240	N/A	20.01
15,051	16,696	12,360	12,062	-3.35	-12.52
25,952	24,344	24,171	23,648	2.77	-0.33
6,696	7,140	7,438	7,447	2.13	0.67
19,256	17,204	16,733	16,201	3.08	-0.76
46,957	46,661	44,674	43,704	6.00	1.19
14,002	13,727	14,218	13,858	4.94	0.03
29,424	28,854	29,083	30,951	1.80	-0.62
22,640	18,855	18,046	18,811	1.30	-4.04
56,328	56,962	58,190	60,837	2.77	-0.03
110,524	111,776	111,853	118,625	3.07	1.31
25,395	25,693	25,088	25,994	0.86	-0.63
1,132	1,039	1,167	1,302	1.90	7.29
83,997	85,044	85,598	91,329	3.83	1.83
43.3	43.9	44.4	45.1	2.25	1.58
9,468	9,526	9,574	9,687	1.22	-0.09
325,851	322,518	316,733	326,677	2.54	-0.48
21,944	23,100	22,852	23,702	4.74	2.03
(16,073)	(16,240)	(15,620)	(16,253)	10.07	0.97
287,834	283,178	278,261	286,721	2.09	-0.74
63,933	73,710	80,680	80,385	7.29	7.86
58,192	61,669	65,760	69,367	6.56	5.57

annual estimates.

standard industrial codes.

information. Values were deflated using the implicit price deflator for personal consumption the earnings sectors registered net annual decreases between 1978 to 1983. Only four sectors showed annual growth rates above 5 percent and all but one of those were below 10 percent.

Unearned income has shown the largest total growth, accounting for over one-third (34.2 percent) of total personal income in 1983. Five years before, unearned income stood at about 27 percent of total personal income, and at 28 percent 10 years earlier. The two categories of unearned income--transfer payments, and rent, dividends, and interest--showed real increases of about 6 and 8 percent annually over the last 5 years.

Federal military income also increased over the last five years, reflecting the effect of military pay raises. Real military income grew about 8 percent annually between 1978 to 1983, but had a negligible effect on total county income because it accounted for less than one percent of total county personal income in 1983.

Mining income is another sector that contributes less than one percent to total county income (0.3), yet it showed the highest average annual growth rate (20 percent) over the last decade. However, such increases had only minor impact on total county income. Mining industry earnings have vacillated over the last five years from $265,000 in 1978 to $1,407,000 in 1980.

Other earnings sectors experienced growth over the last decade--although at much lower rates. All government-sector income averaged annual increases of 1.3 percent between 1978 and 1983, and accounted for 27 percent of total county income in 1983. State and local income provided the bulk of government-sector earnings--21 percent. Over the last five years, earnings in the state and local government sector accounted for roughly the same proportion of total county income--ranging from a low of 20.1 percent in 1982 to a high of 20.9 percent in 1983. In the last 20 years such earnings have exhibited a moderate increase in importance relative to total income; state and local government wages accounted for 18.3 percent of total income in 1962.

Earnings in the transportation and public utilities sector accounted for 10 percent of total county income in 1983. Such income has decreased almost 7 percent since the peak in 1980, partially due to employment declines in the Helena Mountain Bell office.

The recent sluggish growth in county personal income is due to the recession of the early 1980s and its aftermath. Between 1978 and 1983, proprietors' income fell by 62 percent; construction income fell almost 50 percent; and finance, insurance, and real estate income declined almost 20 percent. Earnings in these sectors peaked in 1978 and 1979. Losses continued until 1982 for most sectors, and then rose moderately in 1983.

Farm income has suffered the largest, most consistent declines over the last decade. In 1973, total farm income stood at $9.8 million, about 3 percent of total county income. Ten years later, farm income measured $2.6 million, less than 1 percent of total county personal income. Such declines represent an annual average decrease of 7 percent over that time period.

Lewis and Clark Income Without the Project

Lewis and Clark County total personal income is predicted to increase at a moderate rate throughout the forecast period. Table III-19 shows expected total income.

The 1985 level of personal income is estimated to reach about $513 million and increase 2.5 percent annually above the rate of inflation until 2000 when it tops $742 million.

The Montana economy has been closely linked to the national economy, responding to the same shocks and stimulants (Wanatabe, 1984). Unless the basic structure of the state economy is drastically altered such that it no longer mirrors national trends, it would be unlikely for the state personal income growth to outperform national growth over the long term. Therefore, the baseline forecast used in this analysis assumes that Lewis and Clark County personal income will grow at a rate slightly lower than that predicted for the real gross national product (total national income), yet at a rate consistent with historic rates during periods of both income growth and recession.

FISCAL

Jefferson County

The taxable value of Jefferson County over the most recent five years is shown in table III-22. Since 1970, the total nominal taxable value of the county has grown. However, when the effect of inflation is neutralized, the taxable value of all property in the county has actually declined since 1970. Between fiscal year 1975 (FY75) and FY84, real taxable value declined about 27 percent. But in FY85, it jumped 41.9 percent, almost reaching parity with the 1970 level.

Declines in real taxable value are due to several circumstances. The assessed value of property may not have kept pace with inflation, or some land use values may have declined. Between FY82 and FY84, decreases are partially due to amendments in state law that required re-evaluation of some classes of property, excluded certain property from taxation (for example, business inventories and personal household property), and changed the cost of vehicle licenses to a flat fee for passenger vehicles (Mountain International, Inc., 1984, p. 223).

The large increase in taxable value in FY85 was due to the inclusion of the Bonneville Power (BPA) transmission line in the taxable value of property owned by five private utilities that receive electricity transmitted over the line from the power plants in Colstrip, Montana. The utility companies have formally protested the inclusion of the transmission line. If the appeal is successful, the taxable value of the county could decline by $3.5 million. In an unrelated suit, the Kaiser Cement plant is protesting an assessment equalling $700,000. If both suits are successful, total taxable value would be reduced $4.2 million causing real taxable value in FY85 to fall to $9,160,207, an amount higher than in FY84 yet still one-third below the level 15 years earlier.

Table III-22: Total and Per Capita Taxable Valuation of Jefferson and Lewis and Clark Counties and Montana

	1970	1980	1981	1982	1983	1984	1985
Jefferson County							
Total taxable valuation							
Nominal dollars	$ 6,799,181	$10,054,882	$10,225,526	$11,565,492	$10,887,163	$10,842,689	$15,386,711
1980 dollars	14,745,676	10,054,882	9,414,366	9,940,717	8,808,161	8,772,180	12,448,480
Per capita taxable valuation							
Nominal dollars	1,298	1,430	1,420	1,584	1,491	1,485	N/A
1980 dollars	2,815	1,430	1,307	1,361	1,206	1,201	N/A
Lewis and Clark County							
Total taxable valuation							
Nominal dollars	33,729,722	57,793,213	58,963,634	58,653,528	54,722,100	55,595,896	60,102,034
1980 dollars	73,151,097	57,793,213	54,286,229	50,413,601	44,272,423	44,479,359	48,625,010
Per capita taxable valuation							
Nominal dollars	1,013	1,343	1,340	1,318	1,224	1,249	N/A
1980 dollars	2,196	1,343	1,234	1,133	990	1,010	N/A
Montana							
Total taxable valuation							
Nominal dollars	917,110,954	1,621,951,973	1,845,008,980	2,013,307,433	2,204,492,144	2,242,079,237	N/A
1980 dollars	1,988,977,890	1,621,951,973	1,698,650,095	1,730,468,462	1,783,524,485	1,813,933,983	N/A
Per capita taxable valuation							
Nominal dollars	1,320	2,061	2,345	2,513	2,752	2,779	N/A
1980 dollars	2,863	2,061	2,159	2,160	2,226	2,248	N/A

Source: Montana Tax Foundation, Jefferson County and Lewis and Clark County, in Mountain International, Inc., pp. 218 and 251.
N/A means not available.

The real taxable value in Jefferson County has declined less than that of Lewis and Clark County over the last 15 years (4.2 versus 25 percent). However, the increase in taxable value of the state has outperformed either county (see table III-22). Total real, inflation-adjusted, taxable value in Montana grew above the FY70 level in FY84 for the first time since FY78 and, although dropping between FY84 and FY85, remains greater than the FY70 amount.

The major components of taxable value in the county include nonagricultural land and improvements (35 percent), centrally assessed utility property (27 percent); commercial and industrial machinery and equipment (17 percent); and agricultural-related property (15 percent) (Montana Department of Revenue, Biennial, in Mountain International, Inc., 1984, p. 220). The three largest taxpayers in the county are Kaiser Cement Company, the Golden Sunlight Mine, and the Montana Power Company (Ron Kaiser, pers. comm., August 7, 1984 in Mountain International, Inc., 1984, p. 220). The taxable value of all mineral production in the county ranged from a high of 5.5 percent of total county taxable value in FY85 to a low of 0.65 percent in the previous fiscal year.

As the real taxable value of property in Jefferson County dropped, mill levies increased (see Appendix 7A). The total number of mills levied by the county increased from 33.30 in FY70 to 63.94 in FY85, over a 100-percent increase. However, total mills levied actually peaked in FY82 at 76.37, with the FY85 amount being 16 percent lower.

The general fund levy has been the largest imposed, ranging from almost one half to two-thirds of the total county levy. Together, the general, road, bridge, and poor funds have generally accounted for 79 percent of the total county levy.

Mill levies have increased sufficiently to allow inflation-adjusted budgets to increase (see Appendix 7B). Over the last five fiscal years, total budgeted expenditures have risen 63 percent, with the majority of the growth in the general fund (108.8 percent).

Jefferson County expenditures and revenues by type for FY81 to FY84 are shown in table III-23. Real expenditures for general government, public services, transportation, and education and culture have increased recently. However, the amount spent for public safety has declined 13 percent in real terms between FY81 and FY84.

Property tax receipts, the largest single revenue category, reached the highest level in FY82 and declined 40 percent between FY82 and FY84. Collection from fees, fines, and licenses grew substantially, with most of the increase occurring between FY81 and FY82. Total revenue has risen from FY80, but intergovernmental transfers and property tax revenues have declined.

Town of Boulder

Table III-24 shows selected budget and tax criteria for Boulder from FY79 to FY85. The taxable value fell steadily between FY79 and FY85, decreasing almost 30 percent in real 1980 dollars. The legislative changes that lowered

Table III-23: Jefferson County Expenditure and Revenue Components, FY81 to FY85 (1980 dollars)

Item	FY81	FY82	FY83	FY84	Percentage change FY81 to FY84
Expenditures					
General government	$444,055	$442,653	$451,936	$519,228	16.9
Public safety	382,938	265,093	341,091	331,892	-13.3
Public services	286,736	338,488	351,959	371,049	29.4
Transportation	482,679	496,595	464,353	504,275	4.5
Education and culture	36,044	50,095	35,193	121,635	237.5
Capital outlays/debt service	107,323	231,644	104,136	97,345	-9.3
Miscellaneous	28,449	5,243	31,553	32,766	15.2
Reserves	194,767	366,785	205,764	93,632	-51.9
Total budget	1,962,990	2,196,597	1,986,146	2,071,823	5.5
Total operating budget	1,660,901	1,598,168	1,676,085	1,880,846	13.2
Revenue					
Property taxes	410,865	713,754	488,792	412,408	3.8
Cash balance	792,830	607,982	787,645	771,570	-2.7
Fees, fines, and licenses	87,178	183,317	176,540	246,347	182.6
Intergovernmental transfers	625,186	552,826	429,044	587,292	-6.1
Miscellaneous	23,089	138,716	104,125	54,206	134.8
Total revenue	1,939,147	2,196,597	1,986,146	2,071,823	6.8
Total local revenue	1,313,962	1,643,771	1,557,102	1,484,531	13.0

Source: Jefferson County *in* Mountain International, Inc., 1984, p. 228.

Jefferson County taxable valuation also affected Boulder. However, layoffs at the Boulder River School and Hospital and the recent recession also affected town revenues and expenditures.

Although the total mill levy increased over 50 percent in the last six years, partially as a result of inflationary pressures, the total budget decreased. The largest component of the budget, the general fund, declined almost 35 percent.

Property tax receipts peaked in FY82 at $77,906 then dropped about 16 percent over the last three years. However, the FY85 level was higher than that of FY79. General fund property tax revenues declined, reflecting the effect of falling real taxable values and a fixed mill levy.

Historically, public safety has received the largest portion of the total Boulder budget, and in FY84 was almost one-third of the total budget (see Appendix 7C). Spending for transportation increased the most between FY81 and

Table III-24: Mill Levies, Taxable Valuation, and Budgeted Expenditures for the Town of Boulder, FY 1979-85 (1980 dollars)

Item	FY1979	FY1980	FY9181	FY9182	FY1983	FY1984	FY1985	Percent change 1979-1985
Taxable value	$794,008	$756,104	$669,408	$661,912	$577,336	$607,871	$578,121	-27.2
Total mill levy	68.50	99.50	109.13	117.70	114.20	107.40	113.90	66.28
General fund mill levy	65.00	65.00	65.00	65.00	65.00	65.00	65.00	-0-
Total budget	$193,634	$184,634	168,973	168,245	156,195	197,211	151,711	-21.7
General fund budget	161,709	143,357	117,460	115,113	112.919	151,055	106,026	-34.4
Total property tax	54,374	$75,232	73,053	77,906	62,735	65,273	65,848	21.1
General fund property tax	51,596	49,416	43,461	43,024	35,666	39,512	37,578	-27.2

Taxable value 1974-1975: $581,930
Taxable value 1969-1970: $380,224

Source: Montana Tax Foundation, Annual and Town of Boulder in Mountain International, Inc., 1984, p. 230.

FY84, rising over 90 percent compared to 22 percent growth in the total budget. The total budget by type is greater than that shown in table III-24 because revenue sharing amounts are included.

Inflation-adjusted revenue increased about 13 percent between FY81 and FY84. Intergovernmental transfers increased by 17 percent. Miscellaneous revenues have risen substantially, however, the large increases the last two years are due to positive cash balances from the previous fiscal year (Mountain International, Inc., 1984, p. 232). Property tax receipts have declined slightly over the FY81 level. Locally raised revenue makes up about 62 percent of the total Boulder revenue.

Jefferson County School Districts

There are two high school and eight elementary school districts in Jefferson County. Four that serve the study area are discussed here. The Montana City and Clancy elementary schools serve the northern end of the county and Boulder elementary draws students from the town of Boulder and the immediate vicinity. Jefferson High School serves the northern portion of the county.

The taxable value of each district adjusted for inflation from FY80 to FY85 increased in two districts and fell in the other two (see Appendix 7D).

The taxable value of the Boulder elementary and the high school districts rose substantially between FY84 and FY85 due to inclusion of the BPA transmission line in the tax base. The one-time increase reversed a recent downward trend and total taxable value showed a 63 percent increase in the elementary district and 27 percent growth in the high school district between FY81 and FY85. If the utilities contesting assessment of the power line are successful, the district will lose its recent gains.

The real taxable value of the Clancy and Montana City elementary districts has decreased over the last five years. The Montana City elementary district includes the Kaiser Cement plant. If the plant's tax appeal is successful, the district taxable value would decrease further.

Table III-25 shows the total expenditures, total district property tax revenues, and total district property tax mills for the most recent six fiscal years. The difference between total expenditures and local property tax revenues is made up of payments from the state school foundation program. Between FY80 and FY85, the per pupil school foundation payment increased from $1,405 to $1,748 (1980 dollars), growing almost 24 percent.

Total expenditures in the Clancy elementary district have increased steadily between FY81 and FY85, growing 21 percent above the rate of inflation. However, district property tax receipts have fallen over the same period, showing the largest drop since FY82 (over 50 percent). In FY85, payments from the school foundation program made up about 85 percent of the budgeted expenditures.

Table III-25: Expenditures and Revenues of Selected Jefferson County School District FY80 to FY85 (1980 dollars)

District	FY80	FY81	FY82	FY83	FY84	FY85	Percentage change
Clancy elementary							
Total expenditures	$583,020	$583,233	$627,956	$652,822	$689,873	$707,505	21.35
Total property tax revenue	175,737	171,806	222,402	185,277	167,083	106,341	-39.49
Total mills levied	95.65	92.20	117.92	112.92	110.65	59.52	-37.77
Boulder elementary							
Total expenditures	$459,204	$443,927	$494,349	$533,228	$570,816	$598,175	30.26
Total property tax revenue	126,870	114,476	107,181	103,813	107,988	129,133	1.78
Total mills levied	73.73	72.41	54.37	62.03	75.04	39.89	-45.90
Montana City elementary							
Total expenditures	$205,178	$332,675	$394,626	$396,284	$437,675	$449,620	119.14
Total property tax revenue	108,972	212,409	204,442	219,969	219,214	204,785	87.92
Total mills levied	42.96	86.98	79.77	89.37	90.12	83.18	93.62
Jefferson high school							
Total expenditures	$632,509	$647,738	$674,681	$707,025	$765,018	$756,275	19.57
Total property tax revenue	255,010	236,390	239,445	237,543	239,331	192,003	-24.71
Total mills levied	34.88	38.65	35.84	39.70	43.09	22.94	-34.23

Source: Jefferson County School Districts in Mountain International, Inc., 1984, pp. 243, 245, 247, and 249.

Educational spending in the Boulder elementary school district has grown over one-third in real inflation-adjusted dollars over the last five years. Property tax receipts also increased, but by a much smaller percentage (about 2 percent). District levies decreased by almost half. School foundation payments made up 78 percent of the FY85 budget.

Inflation-adjusted expenditures grew over 100 percent in the last five years in the Montana City elementary school district, partially as a result of continuing enrollment increases. The number of students increased from an average of 86 annual number belonging (ANB) in FY80 to 117 ANB in 1985, about five per year.

Property tax receipts have risen also, about 88 percent. The total number of mills levied by the district has grown from 42.96 to 83.18, nearly doubling over the last five fiscal years. State school foundation payments provide about 46 percent of the total budget.

Real expenditures have grown also for the Jefferson high school district, rising about one-fifth. However, the real value of property tax receipts has fallen almost 25 percent, mirroring the decline in mill levies and real property values. State school foundation payments have provided an increasing share of total district revenue, almost three-quarters of the total district budget in FY85.

Lewis and Clark County

Lewis and Clark County has enjoyed a relatively stable economy compared to many Montana counties. However, the real inflation-adjusted per capita taxable value of the county is below that of Jefferson County and Montana as a whole (see table III-22). Over the last 15 years, the total real taxable valuation declined about 34 percent and per capita taxable value decreased over 50 percent. In FY84, inflation-adjusted taxable values increased for the first time since FY80.

The taxable value was affected by changes in state law excluding certain property from the tax rolls and by the recession. The major components of taxable value in FY84 were nonagricultural land and improvements (for example, city lots, homes) (52 percent); personal property (30 percent); and centrally assessed utility property (15 percent). The county does not have a strong industrial sector, or natural resource-based industries that could provide a growth stimulus. The three largest taxpayers are Mountain State's Telephone, the Montana Power Company, and ASARCO, Inc. (Mountain International, Inc., 1984, p. 252).

Declines in the real value of taxable property and inflation-caused mill levies to increase (see Appendix 7E).

The total levy has more than doubled over the last 15 years, with the bulk of the increase rising 60 percent since FY80. Recent increases are due to the declines in real taxable value.

Although total levies have increased, the inflation-adjusted budget by major fund did not rise (see Appendix 7F).

The total general fund budget has decreased about 2 percent from FY79 to FY85, showing the most significant drop in FY80. The poor fund and road and bridge budgets showed even greater declines over the last six years, about 36 to 38 percent respectively. However, total spending in the county increased 3.1 percent above the rate of inflation, indicating growth in spending in the remaining funds.

Table III-26 shows county expenditures and revenues by type. Spending for general government activities has increased a modest 3 percent. Education and cultural outlays rose more, about 30 percent. Miscellaneous spending increased over 650 percent.

The total operating budget decreased almost 4 percent, with the largest decline in public service spending, partially due to state assumption of the county welfare program. Outlays for public safety and budgeted reserves also decreased, although by lesser amounts.

Property tax receipts have provided the bulk of county revenue, accounting for 46 percent of total revenue and over half of all local revenue. The amount of real property tax collections in FY84 increased almost 5 percent over the FY81 level, after decreasing in FY82 and FY83.

Intergovernmental transfers have fallen almost one-quarter since FY81. Miscellaneous revenues grew almost 460 percent, but the FY84 amount was lower than collections in the previous year.

City of Helena

Real taxable value of the city of Helena has declined steadily between FY70 to FY84 (see table III-27). In FY85, taxable value increased above the level of the previous year, but was still almost one quarter below the level six years previously. Total mill levies have risen as a result, almost 17 percent since FY79. However, the total mills imposed actually reached a peak in FY83 and have declined to a level consistent with FY82.

The total budget has grown about 8 percent, and the major component, the general fund budget, has risen 3 percent. The real value of total local property tax revenues have fallen over the last six years, almost 11 percent, indicating that budgetary growth has been funded by other sources.

Mill levies for the city of Helena have increased almost 30 percent in the last five fiscal years (see Appendix 7G). Inflation and declining real taxable value are responsible for upward pressure on mill levies. The city levy has risen 13 percent and has accounted for a steadily decreasing percentage of the total levy imposed on city property. The county levy and countywide general school levy have grown in tandem and are a higher proportion of the total levy in FY85 than the city levy.

Table III-26: Lewis and Clark County Expenditure and Revenue Components, FY81 to FY84 (1980 dollars)

Item	FY81	FY82	FY83	FY84	Percentage of total FY84 budget	Percentage change FY81 to FY84
Expenditures						
General government	$1,739,414	$1,647,183	$1,678,207	$1,789,202	21.45	2.86
Public safety	1,136,203	1,174,981	980,214	1,078,540	12.93	-5.08
Public services	2,003,711	1,995,874	1,645,750	1,360,399	16.31	-32.11
Transportation	1,002,356	1,076,086	917,757	1,014,594	12.16	1.22
Education and culture	337,054	572,283	389,102	428,988	5.14	27.28
Capital outlays/debt service	1,161,425	877,238	1,188,120	1,233,991	14.79	6.25
Miscellaneous	45,343	179,862	470,401	342,443	4.11	655.22
Reserves	1,146,187	1,142,324	799,653	1,093,059	13.10	-4.64
Total budget	8,571,694	8,665,833	8,069,203	8,341,216	100.00	-2.69
Total operating budget	6,264,081	6,646,271	6,081,430	6,014,166	72.10	-3.99
Revenue						
Property taxes	3,854,115	3,108,519	3,602,955	4,046,840	48.52	5.00
Cash balance	1,539,224	2,06,123	882,102	1,649,069	19.77	7.14
Fees, fines, and licenses	1,102,528	1,511,720	680,318	839,594	10.07	-23.85
Intergovernmental transfers	1,993,648	1,718,450	1,953,425	1,554,888	18.64	-22.01
Miscellaneous	120,103	396,625	869,500	671,913	8.06	459.45
Total revenue	8,609,616	8,795,437	8,069,203	8,762,303	105.05	1.77
Total local revenue	6,615,969	7,076,987	6,115,779	7,207,415	86.41	8.94

Source: Lewis and Clark County *in* Mountain International, Inc., 1984, p. 256.

Table III-27: Mill Levies, Taxable Valuation, and Budgeted Expenditures for Helena, FY79 to FY80 (thousands of 1980 dollars)

Item	FY79	FY80	FY81	FY82	FY83	FY84	FY85	Percentage of change FY79 to FY85
Taxable value	$33,485	$30,627	$29,166	$26,400	$23,058	$24,339	$25,440	-24.0
Total mill levy	64.32	66.32	66.19	75.10	83.53	76.87	75.17	16.79
General fund mill levy	54.25	55.23	55.27	62.05	62.88	55.54	55.47	2.25
Total budget	$4,318	$4,112	$3,909	$3,809	$3,753	$4,426	$4,664	7.9
General fund budget	4,022	3,828	3,661	3,466	3,284	3,931	$4,154	3.3
Total property tax revenue	$2,148	$2,031	$1,931	$1,982	$1,985	$1,880	$1,911	-11.0
General fund property tax revenue	1,817	1,692	1,612	1,638	1,482	1,369	1,411	-24.7

Source: City of Helena in Mountain International, Inc., 1984.
Taxable value FY75: $35,559
Taxable value FY70: $40,183

Rising mill levies have contributed to increased operating budgets (see Appendix 7H). The total operating budget has risen by almost 20 percent since FY81. The largest increase was for capital outlays and debt service. City spending for transportation grew almost 50 percent. Expenditures for public safety rose about 20 percent and about 8 percent for general government. Public services budgets declined almost one-third.

Property taxes are the largest source of revenue for Helena, providing 38 percent of total revenue and 46 percent of total local revenue in FY84. The real value of intergovernmental revenues has increased recently and accounted for 17 percent of total FY84 revenue. Collections for fees, fines, and licenses have fallen since FY81, but still account for over one-fifth of all revenue. Miscellaneous revenues have grown substantially, about 300 percent, accounting for almost one-quarter of total FY84 revenue.

City of East Helena

Table III-28 shows selected budget and revenue items for the city of East Helena. Taxable value (adjusted for inflation) has shown the same pattern as in Lewis and Clark County. Taxable value declined steadily from FY80 to FY84, increasing in FY85, yet not enough to be above the FY80 level. The total decline in the last five years was about 6 percent, reflecting the effects of the recession and of changes in state tax law.

Over the same time period, the number of mills levied increased slightly more than 15 percent. Such increases caused total inflation-adjusted budgeted amounts to increase. City expenditures actually rose almost one-third more than the rate of inflation over the last six years. Property taxes provided a larger percentage of the total FY85 (98.4 percent) than in previous years (about 98 percent). As in other jurisdictions in the study area, the general fund budget receives the largest percentage of the total budget and accounts for the majority of the total mills levied.

Lewis and Clark County School Districts

Lewis and Clark County has 13 school districts. Four elementary districts and one high school district, which serve the study area, will be discussed.

The real, inflation-adjusted taxable value of each school district has fallen over the last five years (see Appendix 7I). The taxable value of Kessler elementary school district decreased the most, slightly over one-fifth. The taxable value of all districts declined from FY81 to FY84. Although each district experienced an increase in real taxable value in FY85, those amounts were still below FY80 values.

In response to real falling taxable values, districts have increased mill levies (see table III-29). The Helena high school district increased levies almost 60 percent over the last five years. Helena elementary district was the only other to increase levies over 50 percent.

Table III-28: Mill Levies, Taxable Valuation, and Budgeted Expenditures for East Helena, FY79 to FY85 (1980 dollars)

Item	FY79	FY80	FY81	FY82	FY83	FY84	FY85	Percentage of change FY79 to FY85
Taxable value	$3,419,540	$3,903,840	$3,630.755	$3,642,351	$3,105,310	$2,560,476	$3,224,129	-5.71
Total mill levy	56.00	60.00	65.00	70.10	75.00	82.00	64.00	15.36
General fund mill levy	52.00	57.40	60.70	65.00	74.40	78.00	63.00	21.15
Total budget	$312,479	$372,667	$340,711	$280,399	$295,681	$304,247	$412,166	31.90
General fund budget	292,461	348,395	308,654	252,998	276,260	290,071	408,942	11.95
Total property tax revenue	$173,656	$234,180	$235,964	$255,288	$248,408	$257,404	$206,338	18.82
General fund property tax	161,252	224,032	220,354	236,715	231,019	244,848	203,114	25.96
Taxable value FY75	$3,628,373							
Taxable value FY70	$3,070,495							

Source: Montana Tax Foundation and City of East Helena Annual Budgets, in Mountain International, Inc., 1984, p. 263.

Table III-29: Selected Lewis and Clark County School District Levies, FY80 through FY85

Fiscal year	Helena elementary district #1	Kessler elementary district #2	Warren-Darcy elementary district #3	East Helena elementary district #9	Helena high school district #1
1980	112.13	91.49	130.28	90.60	41.56
1981	133.64	117.52	139.52	94.21	50.41
1982	N/A	N/A	N/A	N/A	N/A
1983	N/A	N/A	N/A	N/A	N/A
1984	149.25	126.52	150.49	104	60.48
1985	169.06	129.83	158.74	119.80	66.56
Percentage increase	50.8	41.9	21.8	32.2	60.2

Source: Montana Tax Foundation, annual.

SOCIOLOGY

Study Area Definition

The proposed Montana Tunnels project is located in northern Jefferson County, Montana, near the community of Wickes. The project would affect the demographic environment of Jefferson County roughly corresponding to the Boulder Census Division and in southern Lewis and Clark County corresponding to the Helena Census Division (see figure III-12).

For purposes of this study, the aforementioned counties and census censual divisions (CCDs) will constitute the local impact study area. The census enumeration districts (EDs) and incorporated communities within these census divisions are grouped into sub-local study areas as illustrated in table III-30. When possible, data and inferences are presented at the sub-local level. In particular, population projection and growth are presented for the county census divisions and incorporated communities.

The major trade center of the study area is the city of Helena in Lewis and Clark County. The majority of the people currently residing in the impact area work in Helena. In 1980, the population of the Helena Census Division was 38,853 compared to 4,518 people living in the Boulder Census Division.

Demography

Jefferson County

In 1980, the U.S. Bureau of the Census reported the population of Jefferson County to be 7,029 people, an increase of over 34 percent from the 1970 census county of 5,238 (or an annual growth rate of about 3 percent). Most of

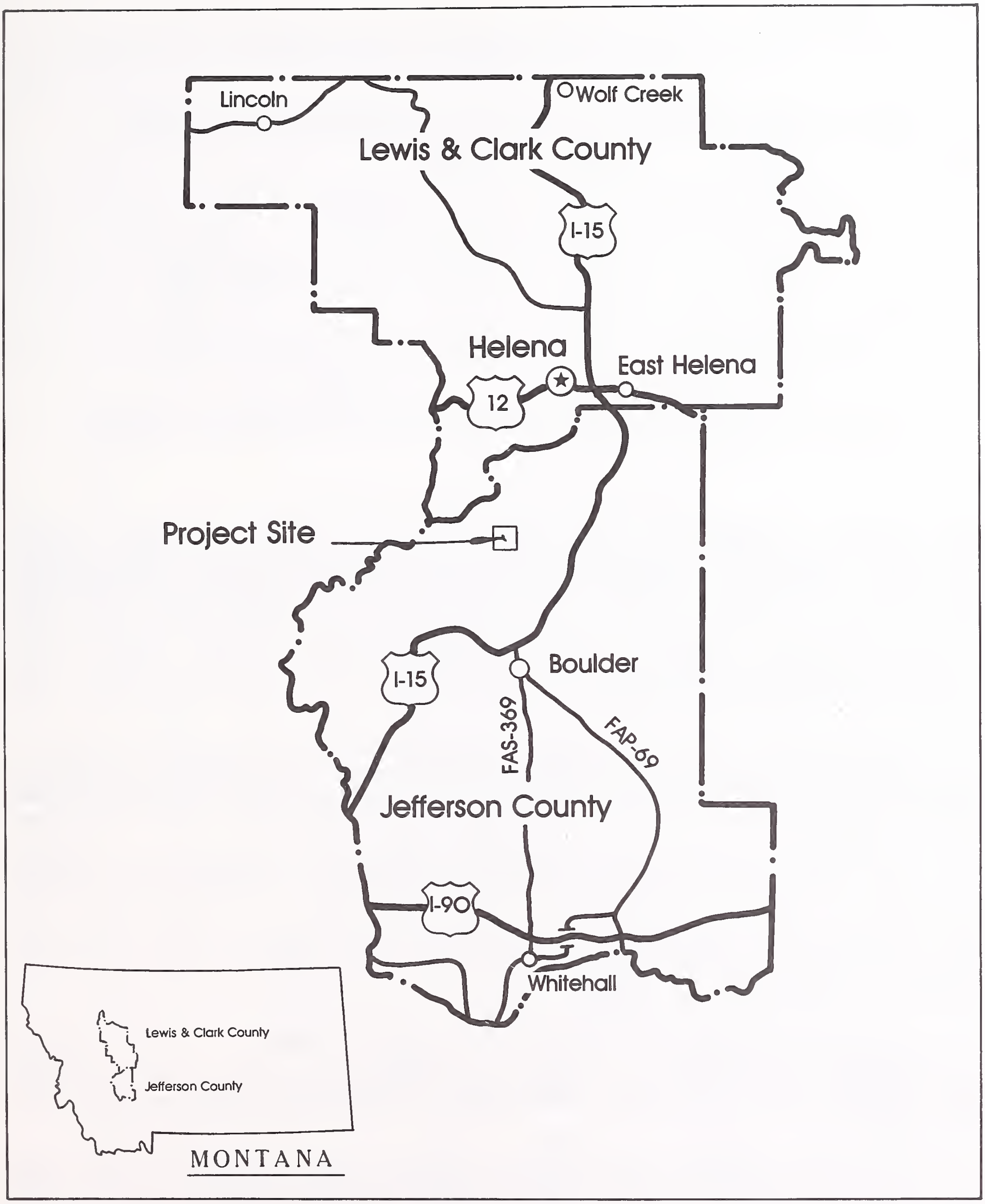

Figure III-12
The Montana Tunnels project would operate in Jefferson County and affect the socioeconomic environment of Lewis and Clark and Silver Bow counties as well.

Table III-30: Local Impact Study Areas--Montana Tunnels Project

Local area/sub-local area	Census/enumeration districts
Jefferson County	
Boulder Census Division	CCD 005
Town of Boulder	Place 0075
Clancy (including Jefferson City)	ED 0932
Montana City	ED 0929, ED 0930, ED 0931
Lewis and Clark County	
Helena Census Division	CCD 010
City of Helena	Place 0325
Town of East Helena	Place 0210

Source: U.S. Department of Commerce, 1981.

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this increase occurred in northern Jefferson County near Montana City, which serves as a "bedroom community" for the city of Helena. Table III-31 illustrates current population estimates and components of change for Jefferson County from 1980 through 1984. Little growth had taken place until 1983, when a rather substantial number of people entered Jefferson County. Part of this in-migration may be attributable to the opening of the Golden Sunlight Mine near Whitehall and the continued growth of the area around Montana City and Clancy.

Population estimates presented in tables III-31 and III-34 are based on county births, deaths, school enrollment data, federal income tax returns, and Medicare data.

The population density of Jefferson County is 4.2 persons per square mile; the state density is 5.4 persons per square mile. The entire population of Jefferson County is classified as rural (those living in places with less than 2,500 people) compared to the 1980 state rural figure of 47.1 percent. In 1980, 97.7 percent of the county was classified as white and the median age was 30 for both males and females.

The number of households in Jefferson County in 1980 was 2,362, yielding an average household size of 2.84, an 8 percent decrease from the 1970 average size of 3.09. The 1980 average is slightly less than the state household size of 3.1 people.

The educational attainment of the Jefferson County residents is less than the state norm, with 71.6 percent of the people completing 12 years or more of school (high school graduate). The percent of county residents completing 16 years or more of school (college-graduate level) is about the same as the state average of 15 percent.

In 1981, estimated per capita income of Jefferson County was $7,045 (U.S. Department of Commerce, 1984), about 4 percent less than the state average of

Table III-31: Local Area Population Estimates for Jefferson County, Montana

Area	Census 1970	Census 1980	Estimated 1984	Percentage of change 1980-1984
Jefferson County	5,238	7,029	8,000	13.8
Boulder CCD	3,350	4,518	5,160	14.2
Town of Boulder	1,342	1,441	1,650	14.5
Clancy	N/A	556	640	15.1
Montana City	N/A	1,980	2,330	17.6
Remainder of CCD	N/A	541	540	-0-
Remainder of county	1,888	2,511	2,840	13.1

Sources: U.S. Department of Commerce, 1981. Montana Office of Public Instruction, 1980-84.

$7,308. However, according to the 1980 census, only about 7.2 percent of those people for whom poverty status was determined in Jefferson County were actually below the poverty level. The county average is less than the state average of 12.3 percent.

Jefferson County Communities

Since 1970, the population of the town of Boulder has increased from 1,342 to an estimated 1,650 in 1984 (see table III-32). During this same time period, the population of the areas of Clancy and Montana City have also grown markedly. These communities have developed primarily because the rates of property taxation are lower than in Lewis and Clark County and because of the scenic beauty and rural lifestyle available to those who work in Helena.

Table III-32: Local Area Population Estimates for Jefferson County, Montana

Area	Census 1970	Census 1980	Percentage estimated 1984	Change 1980-84
Jefferson County	5,238	7,029	8,000	13.8
Boulder CCD	3,350	4,518	5,160	14.2
Town of Boulder	1,342	1,441	1,650	14.5
Clancy	N/A	556	640	15.1
Montana City	N/A	1,980	2,330	17.6
Remainder of CCD	N/A	541	540	-0-
Remainder of county	1,888	2,511	2,840	13.1

Source: U.S. Department of Commerce, 1981, and Montana Office of Public Instruction, 1980-84.

As illustrated in table III-32, most of the sub-local areas in Jefferson County have grown at about the same rate since 1980. The 1984 estimates were calculated using the 1970-80 trends, when available, and 1980 and 1984 school enrollment data.

Selected demographic characteristics for local communities within the study area are presented in table III-33. Within Jefferson County, the average household size ranges from 2.95 in Clancy to 3.23 in the Montana City area. Montana City also has a larger proportion (34.7 percent) of people under the age of 18 than do the other areas of Jefferson County. The 1980 median family income ranges from $23,068 in the Montana City area to $12,437 in Boulder. However, because these 1980 income figures are based on a 20 percent sample of the 1980 census, such estimates should be viewed with some skepticism.

Lewis and Clark County

The U.S. Bureau of the Census reported the 1980 population of Lewis and Clark County to be 43,039, representing an increase of 29.3 percent over the 1970 census count of 33,281. Nearly all of the 1970-80 growth occurred in the Helena valley and the surrounding areas including housing developments on the outskirts of East Helena. Table III-34 shows the growth of Lewis and Clark County since 1980. These figures show an average annual growth rate of about 1.5 percent. The population estimates for 1980 through 1984 are prepared in the same manner as the figures presented in table III-31.

In 1981, the estimated per capita income was $8,219 for Lewis and Clark County, 12.4 percent higher than the state average of $7,309 and 16.6 percent higher than the per capita income of Jefferson County (U.S. Department of Commerce, September 1984). In fact, the average income in Lewis and Clark County ranks near the highest of all counties in the state. This fact is supported also by 1980 census estimates (based on a 20 percent sample) where the median family income for Lewis and Clark County was $16,960 compared to the state median of $15,424.

The population density of Lewis and Clark County is 12.4 people per square mile, nearly triple the density of Jefferson County. About one-half of the county population is classified as rural, and in 1980, 97.7 percent of the county was classified as white--about the same as Jefferson County and the state average.

The number of households in Lewis and Clark County in 1980 was 16,066. The average household size was 2.60 persons, somewhat less than both Jefferson County (2.84) and the state average (3.10).

The median age of those people living in Lewis and Clark County was 28.9 years compared to the state average of 29.0 (1980 census). Of those people living in Lewis and Clark County who were 18 years old and over, 82.1 percent had completed 12 years or more of schooling. This percentage is higher than both Jefferson County (71.6 percent) and the state average (75.4 percent). The percentage of adults completing 16 or more years of schooling was 20.4 percent compared to the state average of about 15 percent.

Table III-33: Selected Demographic Characteristics of Jefferson County Communities, 1980

Characteristic	Jefferson County	Boulder	Clancy area	Montana City area
Households	2,362	483	182	610
Persons per household	2.98	2.98	2.95	3.23
Age characteristics				
Under 18	32.7%	27.2%	34.6%	34.7%
18-64	48.4%	65.7%	57.2%	58.8%
65 and over	8.9%	7.1%	8.2%	6.5%
Median family income	$16,777	$12,437	$19,922	$23,068

Source: U.S. Department of Commerce, 1980.
Note: Clancy area includes Jefferson City (see table III-30 for enumeration districts).

Table III-34: Estimated Population and Component Changes for Lewis and Clark County

Year	Estimated population	Actual births	Actual deaths	Estimated migration
1980	43,039	--	--	--
1981	43,900	779	335	417
1982	44,400	836	356	20
1983	45,200	795	363	368
1984	45,800	818	329	111

Source: U.S. Department of Commerce, 1985b, and Montana Department of Health and Environmental Sciences, Annual Reports.
Note: Years 1981-84 are estimates and are rounded off to the nearest hundred. Year 1980 is the active census count.

Lewis and Clark County Communities

Since 1970, the major growth area of Lewis and Clark County has been in the Helena Census Division and, in particular, the area around Helena and East Helena (table III-35). These estimates were made using extensions of 1970-80 growth patterns and 1980-84 school enrollment changes.

Sub-local area demographic characteristics in Lewis and Clark County are presented in table III-36. Within Lewis and Clark County, the average household size ranges from 2.97 in the rural areas (that is, Helena valley) of the Helena Census Division to only 2.53 within the city of Helena.

Table III-35: Local Area Population Estimates for Lewis and Clark County

Area	Census 1970	Census 1980	Estimated 1984	Percentage change 1980-84
Lewis and Clark County	33,281	43,039	45,800	6.3
Helena CCD	28,832	38,853	41,500	6.8
Helena	22,730	23,938	24,800	3.6
East Helena	1,651	1,647	1,650	0.0
Remainder of CCD	4,451	12,268	15,050	13.4
Remainder of county	4,449	4,186	4,300	2.7

Source: U.S. Department of Commerce, 1981 and Montana Office of Public Instruction, 1980-84.

Table III-36: Selected Demographic Characteristics of Lewis and Clark County Communities, 1980

Characteristic	Lewis and Clark County	Helena	East Helena	Remainder Helena CCD
Households	16,066	9,475	621	4,469
Persons per household	2.60	2.53	2.65	2.97
Age characteristics				
Under 18	29.3%	29.1%	26.3%	30.5%
18-64	61.1%	61.4%	62.4%	57.4%
65 and over	9.6%	9.5%	11.4%	12.1%
Median family income	$16,990	$16,440	$14,886	$17,200

Source: U.S. Department of Commerce, 1980.

The Helena valley differs slightly from Helena and East Helena in age make-up of the population, with the valley having a larger proportion of people under 18 and over 65. This part of the Census Division also has a higher median family income ($17,200) when compared to $16,440 in Helena and $14,886 in East Helena.

Baseline Population Projections

The baseline population projections presented in table III-37 are the product of a demographic/economic simulation model that used cohort-survival techniques and expected labor force participation rates to project county population in 5-year intervals to the year 2000. These projections represent a stable growth rate (about 1 percent in Lewis and Clark County, and nearly 2 percent in Jefferson County). Northern Jefferson County is expected to continue to grow at a faster rate than the rest of the county.

Table III-37: Baseline Population Projection for Local Impact Study Area

Place	Census 1980	Estimate 1984	Projections 1985	1990	1995	2000
Jefferson County	7,029	8,000	8,000	8,500	9,000	9,800
Boulder CCD	4,518	5,160	5,100	5,500	5,900	6,600
Boulder	1,441	1,650	1,650	1,700	1,800	1,900
Clancy	556	640	650	700	800	850
Montana City	1,980	2,330	2,300	2,600	2,800	3,350
Remainder of county	2,511	2,840	2,900	3,000	3,100	3,200
Lewis and Clark County	43,039	45,800	46,000	50,100	55,800	60,200
Helena CCD	38,853	41,500	41,700	45,400	50,800	54,800
Helena	23,938	24,800	24,800	25,900	26,800	28,400
East Helena	1,647	1,650	1,600	1,700	1,800	1,900
Remainder of county	4,186	4,300	4,300	4,700	5,000	5,400

These baseline population projections are consistent with the population projections produced by the Montana Department of Commerce. Both projections tend to run about 5 to 10 percent higher than those reported in the project application (1984). One reason for this discrepancy is that these projections have been adjusted to conform with 1984 estimates published by the Bureau of the Census, which are higher than the 1984 estimates in the project application.

Social Life

Information on social life was taken predominantly from the baseline reports of the project application.

History

Social and economic development of Lewis and Clark and Jefferson counties began with settlement of the area by gold and silver miners in the 1860s. The proliferation of mining and related activities led to that establishment of mining camps and demands for goods and services.

The rapid influx of miners in the 1860s, coupled with inefficient transportation systems, created a need for local good production and, as a result, ranching and farming developed in the Boulder and Helena valleys. Mining and agriculture continued to flourish with the construction of the intercontinental Northern Pacific Railroad through Helena with extensions to Wickes and Butte in 1883. The railroad provided opportunities for regional and national markets with Helena and Boulder becoming the dominant commercial centers.

As the market for precious metals declined and ore deposits became more costly to extract, the mining industry suffered a precipitous decline. By the 1890s, most mines had closed and some settlements had become ghost towns or much reduced in size (such as Wickes, Elkhorn, Comet, and Diamond City). The communities that survived the collapse of mining (Helena and Boulder, for example) developed socially and economically as marketing and distribution centers for ranchers and as centers for state government agencies and institutions.

The Boulder River School and Hospital (BRSH), a state institution for the developmentally disabled, opened in Boulder in 1894 with 10 students and a staff of 5. The institution continued to grow until 1970, when the resident population peaked at 840 and the staff at 524; the BRSH has been the largest employer and economic base for Jefferson County.

Helena became the state capital in 1895, and has been the economic foundation of Lewis and Clark County. Average employment for state government in Lewis and Clark County reached a peak of 4,043 in 1980, and has declined slightly to 3,982 in 1984 (Jan Clack, Census and Economic Information Center, Montana Department of Commerce, pers. comm., October 1985). Economic growth has continued at a slow but stable rate since the early 1970s.

Social Values

Residents of Jefferson County value the rural nature of the area but wish to improve the quality of life by improving community services, facilities, and the local economic base. The natural environment of the region is viewed by citizens of both Jefferson and Lewis and Clark counties as an asset that compensates for some social and economic opportunities which may not be readily available in Montana. The Missouri River and its series of reservoirs are major recreational resources as are the nearby public forest lands.

Social Structure and Interaction

The social structure of Lewis and Clark and Jefferson counties has urban, suburban, and rural components. Helena and East Helena are the largest urban centers in the area. The Whitehall region of Jefferson County and outside of the Helena Valley in Lewis and Clark County are predominantly agricultural. Northern Jefferson County in the Montana City and Clancy areas is dominated by suburban residents who commute to Helena for jobs in state and federal government and private businesses.

The lifestyles and personal values of residents of Lewis and Clark and Jefferson counties reflect their occupations, incomes, and history in Montana. The ranching community, for example, is typically comprised of long-established families in the region who are conservative in life style and politics. The physical demands and economic risks of agriculture have necessitated long-term commitments of resources and adoption of such personal attributes as frugality, self-reliance, and conservatism.

Lifestyles of the Boulder-Basin area citizens have been shaped by a long period of economic transition. Closure of mines and uncertain future of the

BRSH has created a fragile economic base and anxiety toward the future. Per capita income is lower and unemployment is higher than the state average. Residents of the area generally have a strong interest in economic developments that can employ unskilled and semi-skilled workers.

The urban segment of Lewis and Clark County is comprised primarily of white collar workers with a small number of long-term residents who have earned their living in agriculture, forestry, or mining operations. The urban population is generally more liberal politically, has a higher proportion of workers with specialized educations, and is more affluent than the population in the Boulder-Basin area.

Settlement of the northern end of Jefferson County has rapidly increased over the last 15 years as Helena-based workers have sought the amenities of suburban or semi-rural living. These Jefferson County residents--economically, socially, and demographically--are more like Helena residents than citizens of Boulder. These commuting residents identify strongly with Helena, although they pay taxes and send their children to school in Jefferson County.

Social Institutions--Economic Life

The economy of Lewis and Clark County is dominated by state, local, and federal government employment, which together account for about one-third of employment within the county. Other major private employers include Mountain Bell, St. Peter's Hospital, ASARCO, Helena Regional Airport, Montana Physicians' Service, Carroll College, and the Montana Power Company. Employment in agriculture has declined in Lewis and Clark County over the last decade. Unemployment in the county over the last 14 years has been relatively low (4.9 percent) as compared to the state average of 6.0 percent. Because of the diverse economic base and the stable nature of dominant employers, Lewis and Clark County is economically more stable and affluent than Jefferson County.

Social Problems

Jefferson County has a crime rate well below the state average. There is, however, a perception that criminal and mischievous activity, originating in Helena and Butte, becomes law enforcement problems in Jefferson County due to the proximity of the county to these major population centers.

Recent reductions in the sheriff department's law enforcement personnel are also of concern to some citizens of Jefferson County. Some residents feel that the reduction of 2.5 positions seriously impairs the ability of the sheriff to protect citizens and property.

Other problems in Jefferson County include high seasonal unemployment, friction between landowners and recreationists, and the uncertain future of the BRSH. The rapid population growth at the north end of the county has generated service demands that tax the local government's available financial resources.

The uncertain future for the BRSH causes social and economic concern for employees, their families, local businesses, and the community as a whole. The presence of this institution in Boulder for nearly 100 years has made the BRSH an important socioeconomic force in the community.

Community Services

Information on community services in the study area was primarily taken from the baseline reports of the project application (1984). Personal interviews with service providers were conducted to update information.

Education

In the Jefferson County portion of the study area, there are elementary schools at Montana City, Clancy, and Boulder, and there is a high school in Boulder. The Lewis and Clark County portion of the study area has 14 elementary schools, 2 middle schools, and 2 high schools in Helena, and 2 schools in East Helena serving grades K-8.

Student enrollment at the Montana City and Clancy elementary schools has been increasing and is projected to continue to increase due to the settlement in northern Jefferson County and increased birth rates in that area. Table III-38 shows the 1985-86 enrollment and capacity for schools in the Jefferson County study area. Jefferson High School is presently at capacity; however, an addition is being constructed to provide classroom space for about 80 more students. This addition should be completed in January 1986.

Table III-38: Enrollment and Capacity of Jefferson County Study Area Schools

School	1985-86 enrollment	Capacity
Montana City Elementary	132	145
Clancy Elementary	313	340
Boulder Elementary	213	245
Jefferson High School	224	224

Source: Helen Williams, Jefferson County superintendent of schools, pers. comm., October 1985.

Note: The Montana City School could accommodate 145 students but would be overcrowded at that level. Similarly, enrollment at 340 at the Clancy School would be an overflow of students.

Elementary schools in Helena with the exception of the Warren/Darcy School have declined in enrollment over the past 5 years. Except for the Four Georgians, the elementary schools could accommodate more students. The 2 high schools and the Helena Middle School could also absorb about 100 more students, but C.R. Anderson is at maximum capacity now (Roger Eble, superintendent, Helena Schools, pers. comm., October 1985).

School District #9 (East Helena) is in the process of constructing a new school; when it is complete (1986), the capacity of all three schools would be 1,300 students. Presently, enrollment is at 940 students and is increasing by 40 to 50 students a year (Jim Koke, School District #9 superintendent, pers. comm., October 1985). If enrollment continues at this rate, more classroom space--as well as teachers--would need to be added within 7 to 9 years.

Law Enforcement

Law enforcement in the Jefferson County study area is provided by the Montana Highway Patrol, the Jefferson County Sheriff's Department, and the Boulder City Police. The highway patrol restricts patrol activities to Interstate 15; sheriff's department officers serve the entire county.

The sheriff's department is headquartered in Boulder. Of the 8 sworn officers, 1 officer is stationed in Whitehall and the other 7 are based in Boulder. A reserve unit of 9 trained volunteers provides assistance to the department (Tom Dawson, Jefferson County sheriff, pers. comm., September 1985). Based on staffing ratios for other comparably sized Montana counties, Jefferson County has a low population-per-officer ratio (1:570), patrols fewer miles of road, and is responsible for smaller areas of land than are many of their counterparts in similarly populated counties. There is, however, a perception that, due to a recent reduction in employees, the department is understaffed (Tom Dawson, Jefferson County sheriff, pers. comm., September 1985).

The sheriff's department also houses 24-hour emergency communications for fire, emergency medical services, and the Boulder City Police Department. The Boulder Police Department has 2 full-time officers, whose jurisdiction is within the town of Boulder.

The department's communication system needs to be upgraded to improve overall emergency response capability. The department currently uses a low-band system that is not compatible with several Jefferson County emergency services as well as other law enforcement agencies.

Construction began in the spring of 1985 on the new law enforcement center in Boulder. When completed, the center will continue to house the emergency response center and an 11-bed jail. The old jail will be used for Justice Court purposes, thereby maintaining the historic integrity of the Jefferson County Courthouse.

In the Lewis and Clark County study area, law enforcement services are provided by the Montana Highway Patrol, the sheriff's department, the Helena City Police, and the East Helena Police Department. The sheriff's department provides services for the county outside of Helena and East Helena. The department staffs 26 sworn officers, 11 jailers, and has a 10-person reserve force. More deputies are needed to adequately patrol the streets (Ed Schild, undersheriff, Lewis and Clark County Sheriff's Department, pers. comm., September 1985).

When compared with other similarly sized Montana counties, Lewis and Clark County deputies patrol about twice as much land area as do their counterparts in other counties. The ratio of deputy-to-rural population (1:671) is 34 percent above the commonly recommended standard of 1 officer per 500 population.

A new city-county law enforcement center which will house a 50-bed jail is scheduled to be constructed by the end of 1985. A new high-band communication system will be in operation by year's end also (Ed Schild, undersheriff, Lewis and Clark County Sheriff's Department, pers. comm., September 1985).

The Helena City Police Department has a staff of 33 sworn officers. Twenty-four officers are on street patrol and 5 are investigators. East Helena maintains a 2-officer police department.

Fire Protection

Fire protection in the Jefferson County study area is provided by 5 volunteer departments (table III-39). On a scale from 1 to 10 with class 1 being the highest rating, the Boulder Fire Department has an above average fire rating (class 6) for a small community, whereas the other Jefferson County departments are not adequate to handle major fires. Fire suppression on public lands within Jefferson County is the responsibility of the Montana Department of State Lands, the U.S. Forest Service, and the Bureau of Land Management. The proposed project site is not within the boundary of a fire district.

Fire protection in the Lewis and Clark County study area is provided by the Helena Fire Department and several volunteer units outside the city limits. The Helena Fire Department has 25 permanent firefighters, a fire chief, an assistant chief, and a fire marshall. The department has agreements with 2 local volunteer fire departments to exchange manpower and equipment but does not assist other departments because of insufficient insurance coverage.

East Helena is served by 28 volunteer firefighters (Ron Fleisner, East Helena fire chief, pers. comm., October 1985). The fire department has 3 fire trucks and a class 5 fire protection rating (Earl Huestis, field representative, Insurance Service Organization, pers. comm., September 1985).

Structural and wildland fires in rural Lewis and Clark County, not under the jurisdiction of volunteer departments or public agencies, are the responsibility of the Lewis and Clark County Fire Department.

Table III-39: Jefferson County Fire Protection

Department district	Number of firefighters	Vehicles	Fire protection rating[1]
Boulder Volunteer Fire Department	28 (12 to 14 active)	2-ton truck with 300-gallon tank, 750-gallons-per-minute (gpm) pump.	6
Boulder Valley Rural Fire District	15	6 vehicles, including a 2-ton truck with 1,100-gallon tank and a 1,000-gallon army tanker.	10
Jefferson City Fire Department	15 (8 to 11 active)	300-gallon-tank truck with 250-gpm pump.	9
Clancy Volunteer Fire Department	28	300-gallon truck and 700-gallon truck.	9
Montana City Rural Fire Department	16	3 vehicles, including "Quick Attack" with 250-gpm pumper, 500-gpm pumper, 1,800-gallon truck with 250 gpm pump.	9

Source: Project application, 1984, and Earl Huestis, field representative, Insurance Service Organization, pers. comm., September 1985.

[1] On a scale of 1 to 10, class 1 is the highest rating and 10 is unprotected.

Ambulance

The Boulder Volunteer Ambulance Service is staffed by 15 certified emergency medical technicians (EMTs), with 1 volunteer certified in mine rescue work. The ambulance service owns 2 emergency-equipped vehicles. Fees for services, donations, and contributions from Jefferson County and Boulder pay for the ambulance and emergency services.

A Quick Response Unit is located in the Montana City-Clancy area. Because the unit does not have emergency vehicles, the volunteers equip their private vehicles with first aid equipment. The volunteers attempt to stabilize the patient until an ambulance arrives.

St. Peter's Ambulance Service in Helena provides emergency care to Lewis and Clark County and northern Jefferson County. The ambulance service employs 7 full-time and 12 part-time EMTs. The 4 emergency vehicles are equipped with 16-channel radios, which provide adequate communications (Jim Detienne, supervisor, St. Peter's Ambulance Service, pers. comm., September 1985).

Hospitals and Long-Term Care Facilities

Jefferson County has no hospitals that are open to the general public. The only long-term facility in Jefferson County is the 67-bed Hillbrook Nursing Home located near Clancy.

In the Lewis and Clark County study area, there are 2 hospitals open to the general public (St. Peter's and Shodair Children's Hospital). The primary hospital, St. Peter's Community Hospital, is a 111-bed facility (Jacqueline McKnight, Licensing and Certification Bureau, Montana Department of Health and Environmental Sciences, pers. comm., September 1985). In 1984, the hospital operated at 61.2 percent capacity (Montana Department of Health and Environmental Sciences, 1984b). St. Peter's has a staff of 74 active physicians and dentists, 38 consulting physicians, 108 registered nurses, and 29 licensed practical nurses (Montana Department of Health and Environmental Sciences, 1984a).

Shodair Children's Hospital is a 36-bed facility offering in-patient care to children 14 years old and younger and out-patient care to both children and adults. In 1984, Shodair reported an occupancy rate of 28.4 percent (Health Planning Bureau, Montana Department of Health and Environmental Sciences, Data Book, 1984). On staff are 49 active physicians, 7 consulting physicians, 15 registered nurses, and 2 licensed practical nurses (Montana Department of Health and Environmental Sciences, 1984a).

There are 3 long-term facilities in Helena--Cooney Convalescent Center (60 beds), Helena Nursing Home (63 beds), and Western Care Nursing Home (108 beds) (Montana Department of Health and Environmental Sciences, 1985).

Physicians

In Boulder, there is 1 doctor serving the community who specializes in family practice. Helena has 66 full-time physicians offering 17 specialized medical fields. Helena also is served by 26 dentists, 3 orthodontists, 1 oral surgeon, 1 periodontist, and several podiatrists, chiropractors, acupuncturists, and optometrists.

Water Supply

The municipal water supply of Boulder is pumped from 4 wells (capacity 1,800 gallons per minute) to 2 elevated storage tanks. Presently it is not necessary to filter or chlorinate the water before distribution. The system provides water for 550 residences, 25 businesses, and serves as a backup for the BRSH. Maximum water consumption is 1.4 million gallons per day (gpd) during the summer peak demand period. The facilities and water supply are adequate, and presently there are 70 to 80 water hookups to vacant residences (Jim Harper, Boulder water superintendent, pers. comm., September 1985).

Rural water supplies throughout both Jefferson and Lewis and Clark counties are predominantly private wells. New subdivisions in the northern part of Jefferson County are supplied by central water systems also pumped from wells.

Helena municipal water is obtained from the Missouri River and from the upper Ten-Mile Creek drainage. Water from both sources must be subjected to treatment before it is distributed. The treatment capacity of the Missouri River water system has recently been expanded from 9.5 million gpd to 12 million gpd to accommodate population growth in the Helena valley.

The Ten-Mile watershed has 2 reservoirs--Scott and Chessman. The Chessman reservoir has not been filled for 2 years because it was declared unsafe by the U.S. Army Corps of Engineers. Studies are being conducted to determine the extent of repairs to make the reservoir operational (Leonard Willett, Missouri River chief plant operator, pers. comm., September 1985). If Chessman reservoir becomes operational, a more reliable source of water would be available.

East Helena municipal water comes from McClellan Creek and 2 wells. The city has applied for a Community Block Grant to upgrade the system so that all water would eventually come from wells (Ed Murgel, East Helena superintendent, pers. comm., September 1985). The existing supply is not adequate during the high demand summer season and water rationing is sometimes necessary.

There are adequate fire flows (a measurement of the capacity of a water system to provide water for firefighters) in the study area (Jim Harper, Boulder water superintendent, pers. comm., September 1985; Dennis Curey, Helena Water Department, pers. comm., September 1985; Ron Fleisner, East Helena fire chief, pers. comm., October 1985). The East Helena fire flow adequacy is a direct result of the successful volunteer efforts of the community. When the fire whistle sounds, residents and businesses have been requested to stop all major uses of water to provide the firefighters with more water. The city of Helena is in the process of installing about 40 hydrants to upgrade the availability of water for fire protection activities.

Wastewater Treatment

Wastewater treatment (sewage) facilities serving Boulder consist of 4-inch to 11-inch branch lines connected to 12-inch clay main lines which discharge to lagoons. After retention for 86 days, the effluent from the lagoons is discharged to the Boulder River. The treatment facilities were constructed in 1967, are in satisfactory condition, and are not approaching design-flow capacity.

Wastewater treatment for Helena includes both primary and secondary treatment with the most recent improvements to the system being completed in 1985. The collection system consists of 110 miles of pipe which are generally in good condition. Liquid effluent from the treatment plant is discharged to Prickly Pear Creek and sludge is press dried and disposed of in a landfill. The plant is currently operating at approximately half of its designed capacity.

East Helena has a secondary treatment facility consisting of 3 aerated lagoons. The system is in satisfactory condition and is operating at approximately 50 percent of its designed capacity.

Most residences outside city limits and in rural areas have individual septic tank systems. Individual septic tank systems in the Helena valley are of concern to health officials because of the potential to contaminate ground water.

Solid Waste

Giulio's Garbage Service provides door-to-door solid waste collection in Boulder. In addition to a solid waste collection fee, all Jefferson County residents and businesses are assessed an annual charge for the Boulder Sanitary Landfill (Dave Kirsch, Jefferson County Solid Waste Management Board, pers. comm., September 1985).

For the communities of Clancy, Jefferson City, Montana City, and northern Jefferson County subdivisions, the county has a solid waste container program. Two to three times a week, refuse--deposited in the 40-yard containers situated in these communities--is hauled to the Boulder Landfill (Jim Leiter, Solid Waste Management Bureau, Montana Department of Health and Environmental Sciences, pers. comm., September 1985). Because the existing refuse containers (green boxes) are often filled to capacity, additional containers in Jefferson City and in Montana City are being constructed. It is unknown at this time whether the added capacity will satisfy the demand (Dave Kirsch, Jefferson County Solid Waste Management Board, pers. comm., September 1985).

The Boulder landfill, located 2 miles south of Boulder, is leased from the state and has been the responsibility of Jefferson County since 1980. The 20-acre landfill has plenty of remaining capacity (Jim Leiter, Solid Waste Management Bureau, Montana Department of Health and Environmental Sciences, pers. comm., September 1985).

Solid waste collection and disposal services in Helena are provided by the City Sanitation Department. The collection system was designed to accommodate about 9,050 residents and currently services about 8,500. The city has provided residents with either 90-gallon individual or 300-gallon commercial containers. Refuse is collected once a week and hauled to the Helena landfill for disposal.

The 17-acre Helena landfill site is leased from Burlington Northern Railroad. The landfill has enough capacity to accommodate Helena and East Helena for six to seven more years (Jim Leiter, Solid Waste Management Bureau, Montana Department of Health and Environmental Sciences, pers. comm., September 1985).

In East Helena, refuse from residences and businesses is picked up twice a week. The solid waste is hauled to the Helena landfill. East Helena has a landfill, but it does not have the classification necessary for garbage disposal; therefore, it is used only for rocks, trees, and similar types of refuse. If managed properly, this landfill will not reach capacity for 10 to 15 years (Ed Murgel, East Helena superintendent, pers. comm., September 1985).

Solid waste from rural areas outside of Helena and East Helena is dumped at the Scratch Gravel Landfill. The Refuse Disposal District owns the landfill and assesses an annual users fee. Rural residents can either haul refuse to the landfill themselves or contract with the City-County Sanitation Service to haul the refuse. It is estimated that the landfill will not reach capacity for three to four years (Jim Leiter, Solid Waste Management Bureau, Montana Department of Health and Environmental Sciences, pers. comm., September 1985).

Utilities

Telephone and gas/electrical services in the study area are provided by Mountain Bell and the Montana Power Company. Telephone service and construction operations are centralized in Helena. Gas and electric service personnel are located in Helena with additional personnel operating the hydroelectric generating plants on dams of the Missouri River east of Helena.

Social Welfare

Funding for social welfare services in both Lewis and Clark and Jefferson counties comes from state, federal, and county sources. The Jefferson County program is administered by the county, whereas the state administers the Lewis and Clark County program. Services provided include

--aid to families with dependent children,
--food stamps,
--social services,
--Medicaid,
--foster care,
--general assistance,
--transient relief, and
--visual services/vocational rehabilitation.

Jefferson County has 1 social worker and 2 eligibility technicians. Because the department is understaffed, 1 eligibility technician works part time as a human resource aide. Lewis and Clark County has 2 supervisors, 3 in-take workers, 4 child protective positions, and 4 adult protective/developmentally disabled workers. Both counties need additional personnel to adequately dispense required services (Rita Pickering, Lewis and Clark County Human Services; Sharon Morrow, Jefferson County Human Services, pers. comm., September 1985).

Commercial Services

Jefferson County is situated among three of Montana's major trade centers--Butte, Helena, and Bozeman. Its location and relatively limited commercial services are factors contributing to a net retail sales cash outflow of the county. Of every dollar spent by Jefferson County residents for retail purchases, 74 cents is spent outside of the county. Butte and Helena probably receive a significant share of this retail spending.

Lewis and Clark County has 510 retail businesses and is ranked sixth among Montana counties for retail sales. A substantial portion of retail sales income is derived from non-resident purchases. Tourism creates about 890 jobs in the local economy.

Housing

Based on U.S. Bureau of the Census data, there were about 17,000 year-round housing units in portions of Lewis and Clark and Jefferson counties composing the study area. About 90 percent of these units were located in Helena, the Helena valley, and East Helena, with the remaining 10 percent distributed in Boulder, Clancy, Jefferson City, Montana City, and Alhambra (table III-40).

Of all year-round housing, about 59 percent are single-family dwellings, 27 percent are multi-family units, and 14 percent are mobile homes. The vacancy rate is 9 percent in the Jefferson County portion of the study area and 7 percent in the Lewis and Clark County portion.

In August 1984, a survey of homes for sale in the study area found that there were 527 homes for sale by Helena and Boulder realtors. Sixty of these homes were located in Jefferson County. The inventory also identified 178 parcels of land available for housing development.

Table III-40: Characteristics of Year-Round Housing in the Study Area, 1980

Type of housing	Boulder	Clancy/ Jefferson City	Montana City/ Alhambra	Helena	East Helena	Helena valley	Total
Single family	274	132	542	5,744	572	2,710	9,974
Percentage of total	52%	70%	88%	56%	87%	58%	59%
Multi-family[1]	94	0	34	4,047	85	234	4,494
Percentage of total	18%	0%	5%	40%	13%	5%	27%
Mobile homes	164	56	43	435	0	1,714	2,412
Percentage of total	31%	30%	7%	4%	0%	37%	14%
Total year-round housing	532	188	619	10,226	657	4,658	16,880
Median value of owner-occupied housing	$33,200	$48,100	$70,800	$51,200	$40,200	$52,500	--

Source: Project application, 1984.

[1] Multi-family units include duplex, triplex/fourplex, and 5- or more unit housing.

Most of the houses available for sale in Lewis and Clark County were in the city of Helena, Unionville, and the Helena valley. Within this area, there were 322 homes and 165 lots for sale. East Helena also had 66 homes and 157 lots for sale.

In addition to homes for sale, there were also rental properties available, primarily in Helena. Over a 1-year period, there was an average of 58 locations for rent per month in Helena. There are relatively few rental units in the Boulder area and these units tend to be fully occupied.

Temporary housing is also available in trailer courts, hotels, and motels. In northern Jefferson County, there are 10 trailer courts with 160 permanent and 28 temporary trailer spaces. Boulder has 4 motels (53 rental units) and 2 apartment buildings (56 rental units). The motels usually have low occupancy in the winter; the apartments are usually fully occupied during the same period.

In southern Lewis and Clark County, there were 31 trailer courts surveyed consisting of 820 units and 272 temporary trailer spaces in 6 courts and campgrounds. The courts generally have stable occupancy rates throughout the year. The campgrounds cater primarily to summer tourists. Of the numerous hotels and motels in the Helena and East Helena areas, at least six (totalling 107 units) frequently house temporary workers.

LAND USE

Land use in and around the proposed 1,549-acre permit area consists of public recreation, livestock grazing, wildlife habitat, mining, logging, and crop production. A major land use in the Montana Tunnels area is public recreation, although recreational use is light compared to other areas in the state. Hunting is the most predominant recreational use, followed by snowmobiling, hiking, and other uses. Poor roads in the area generally limit recreational use to the summer and fall seasons.

Another major land use in the area is wildlife and livestock grazing. The area provides habitat and grazing for both game and non-game wildlife species (see Chapter III--Wildlife). Livestock are present in the area in the spring, summer, and fall--primarily on the rolling grassland hills. About 70 percent of the 1,549-acre permit area is grazable; the average range condition of the grazable areas is good (about 60 percent of climax vegetation). Under present range conditions, the recommended stocking rate for the permit area is 282 cow-calf units (AUMs) for a one-month grazing period, or about 31 AUMs for a nine-month grazing period. The potential stocking rate, if excellent range condition (76 percent of climax vegetation) were reached, is about 401 AUMs for a one-month grazing period, or about 45 AUMs for a nine-month grazing period.

Mining has been an important land use in the area (see Chapter III--Cultural Resources). In the Corbin-Wickes area, mining was a major land use from the 1860s to about 1900. Sporadic mining continued in the area until the 1960s; however, during this period, much of the land was converted to agricultural uses. Even so, numerous mining claims exist in the area today, and some exploratory activities occur in the summer and fall. Logging also occurs on a small scale in the area, and this activity will likely continue.

The permit area contains about 45 acres of cropland. Oats, introduced grasses, and alfalfa are grown on these areas, which are located along the Homestake Creek drainage and in the headwaters of Gregory Gulch.

TRANSPORTATION

Traffic and Road Conditions

The project site is accessible by Interstate Highway 15 (I-15) from the north and south, and county roads west of Jefferson City. Some workers from the Cardwell-Whitehall area may also travel federal aid primary road (FAP) 69 (see figure III-12).

I-15 is a paved, four-lane roadway through most of Jefferson County; a section south of Basin is being reconstructed and will be completed in 1986. FAP 69 is a two-lane, paved road that connects Whitehall to Boulder and eventually deadends at I-15. Two county roads access the minesite directly--the Corbin-Wickes Road, west of Jefferson City, and the Clancy Creek Road, west and south of Clancy.

The Montana Department of Highways (MDOH) periodically inspects all primary and secondary roads in the state and assigns each a sufficiency rating based on structural soundness, safety, and capacity of the road. In 1981, sections of I-15 through Jefferson County had average sufficiency ratings between 81 and 92, with 100 being the top score. A 3.8-mile section was rated as deficient. The 8.7-mile section south of Basin had a sufficiency rating of 44, probably due to reconstruction. When completed in 1986, I-15 will be a four-lane highway for its entire distance in Jefferson County (Mountain International, Inc., 1985, p. 115).

FAP 69 had an average sufficiency rating of 54.0 in 1981. About 15.6 miles of the two-lane road were rated as deficient (Mountain International, Inc., 1985, p. 116).

Average daily traffic counts on I-15 through Jefferson County are shown for selected locations in table III-41. Traffic counts have increased most at the northern end of the county, reflecting the population gains in that area over the last 12 years. Between 1976 and 1983, traffic measured at the Montana City interchange increased almost 40 percent for an average annual growth rate of 4.8 percent. Traffic at the Clancy and Jefferson City interchanges has grown about 4.3 percent annually over that same period. Traffic at these two locations peaked in 1980; however, traffic levels have increased 66 percent from 1970 to 1982 at Jefferson City and 80 percent at Clancy. Traffic recorded near the I-15 Boulder interchange has decreased over the last five years. The number of vehicles recorded at the Jefferson-Silver Bow county line has also declined since 1981, but has averaged a 2.5 percent annual increase between levels recorded in 1976 and 1984.

Table III-41: Historic Traffic Counts along I-15 in Jefferson County[1]

Year	Site #1	Site #2	Site #3	Site #4	Site #5
1970	N/A	N/A	1,373	1,743	N/A
1975	N/A	1,730	1,847	2,183	N/A
1976	1,210	1,856	2,121	2,670	3,330
1977	1,285	2,283	2,359	3,439	4,453
1978	1,020	1,710	2,430	3,120	4,310
1979	1,310	1,827	2,314	2,489	4,524
1980	1,430	1,930	1,880	2,490	3,530
1981	1,530	2,220	2,340	3,000	4,740
1982	1,510	2,190	2,280	3,640	4,060
1983	1,500	1,830	N/A	2,910	4,630
1984	1,470	2,080	N/A	3,140	N/A
Percentage of change over period of record	21.5	20.2	66.1	80.1	39.0
Percentage of change most recent 5 years	12.2	13.8	-3.3	26	1.05
Annual rate of change over period of record	2.5	2.1	4.3	4.3	4.8

Source: Montana Department of Highways, Traffic by Sections, annual.

[1] Site #1 is just north of the Jefferson-Silver Bow county line.
Site #2 is near the I-15 and FAP 69 junction at Boulder.
Site #3 is the Jefferson City interchange.
Site #4 is the Clancy interchange.
Site #5 is the Montana City interchange.
N/A means not available.

Table III-42 shows traffic counts made at two locations along FAP 69. Northeast of Whitehall near the junction of FAP 69 and federal aid secondary (FAS) 359, average daily traffic (ADT) has increased almost 30 percent in the last seven years at an annual rate of 3.6 percent. The opening of the Golden Sunlight Mine near the junction of I-90 and FAP 69 probably accounts for some of the increase measured between 1979 and 1983 at this location. Increases even more dramatic have been recorded at the Boulder city limit near the junction with I-15. The number of vehicles recorded at that location has risen almost 73 percent from 1976 to 1983, for an average annual increase of 8.1 percent. However, most of the increase (about 68 percent) occurred between 1977 and 1978 and traffic has remained relatively stable over the last six years.

Table III-42: Traffic Counts at Selected Locations on FAP 69[1]

Year	Site #1	Site #2
1976	583	1,084
1977	618	1,095
1978	595	1,819
1979	522	1,738
1980	623	1,890
1981	624	1,825
1982	653	1,850
1983	746	1,874
Percentage of change from 1976-1983	30	72.9
Percentage of annual change 1976-1983	3.6	8.1

Source: Montana Department of Highways, Traffic by Sections, annual.

[1] Site #1 is near the junction with federal aid secondary (FAS) 359 north of Whitehall.
Site #2 is at the Boulder city limits near the I-15 junction.

Traffic counts are made infrequently and irregularly on the county roads west of Jefferson City. In 1972, the MDOH measured 127 daily vehicles at the junction of the frontage road into Jefferson City and the access road to the interstate. The same year, an ADT of 67 was recorded at the outer edge of Wickes. In 1983, Robert Peccia and Associates estimated traffic at 86 vehicles per day along the Corbin-Wickes road west of Jefferson City (Mountain International Inc., 1985, p. 116). Over the interim 11 years, there was a total increase of about 28 percent or an annual rate of 2.3 percent. Such statistics should be viewed with some skepticism, however, because of the limited data base.

Traffic Conditions Without the Project

Traffic will continue to increase in the study area due to projected population and employment increases in Jefferson and Lewis and Clark counties (see Chapter III--Employment). If basic employment or population changes occur that are not anticipated in either forecast, traffic levels would also change.

Table III-43 shows anticipated baseline ADT through the year 2000 for locations along I-15 in Jefferson County. The number of vehicles traveling this portion of I-15 is projected to rise throughout the forecast period. The

Table III-43: Estimated Average Daily Traffic on I-15 in Jefferson County

Year	Silver Bow/Jefferson county line	Boulder interchange	Jefferson City interchange	Clancy interchange	Montana City interchange
1985	1,492	2,110	2,163	3,218	4,765
1990	1,605	2,266	2,358	3,635	5,119
1995	1,727	2,433	2,570	3,992	5,499
2000	1,859	2,612	2,802	4,200	5,907
Total percentage of increase	24.6	23.8	29.5	30.5	24.0
Average annual rate of increase	1.5	1.4	1.7	1.8	1.4

Source: DSL working papers, October 1985.

largest increases are projected to occur in the northern section of Jefferson County, reflecting the effect and continuation of the population growth in the northern end of the county. Almost all sections of I-15 are forecast to receive ADT increases of at least 24 percent over the next 15 years.

Table III-44 shows forecasted ADT at two locations on FAP 69. ADT is estimated to grow about 20 percent near the Whitehall-Cardwell area, with annual increases slowing the year the Golden Sunlight Mine is expected to close. Traffic near the FAP 69-I-15 junction increases almost 15 percent over the forecast period, at 1 percent per year.

Table III-44: Estimated Average Daily Traffic at Two Locations on FAP 69

Year	Near FAP 69 junction with FAS 359	Boulder city limits near I-15 junction
1985	757	1,893
1990	813	1,970
1995	872	2,070
2000	904	2,175
Total percentage of increase	19.4	14.9
Average annual rate of increase	1.2	1.0

Source: DSL working papers, October 15, 1985.

There is inadequate data to forecast traffic increases on the Corbin-Wickes county road. However, if traffic were to increase over the next 15 years at the same rate (2.3 percent annually) as measured between the county made in 1972 and 1983, ADT would be 121 vehicles of the small number of observations.

RECREATION

The U.S. Forest Service and the Montana Department of Fish, Wildlife and Parks share the management responsibility for most of the designated recreation areas in Jefferson and Lewis and Clark counties. Together the agencies manage almost 8,000 acres for recreational use in these two counties affected by the Montana Tunnels project. The remaining recreational areas are run by the Montana State Highway Commission (three rest areas) or the public.

Most of the designated recreational areas in Jefferson County occur south and west of Boulder Hot Springs. There are few organized recreational activities in rural Jefferson County. Lewis and Clark County features Montana's state capitol--Helena--which lends the county an urban flavor. The principal designated outdoor recreational areas in Lewis and Clark County cluster around Canyon Ferry Lake.

Jefferson County

Fifteen of the 24 designated recreational areas in Jefferson County occupy the Deer Lodge National Forest. Lewis and Clark Cavern State Park on the county's southern boundary attracts the most tourists; the park is about 40 air miles from the project site.

There are only two designated recreation sites relatively close to the proposed project area. Park Lake Campground and the Jefferson City rest areas in the northern part of Jefferson County are 5 to 6 air miles from the project site, although Park Lake Campground is actually about 25 road miles away. Although not normally considered recreational facilities, the rest areas about one mile north of Jefferson City on Interstate 15 provide a park-like setting of picnic tables, water, and sanitary facilities for the public.

Spring Creek, with a flow rate of about 2.9 cubic feet per second, is not considered a significant sport fishery. Clancy Creek, although a larger stream than Spring Creek, sees only about 320 visitors per year (pers. comm., Bob McFarland, Department of Fish, Wildlife and Parks [DFWP], September 30, 1985). Prickly Pear Creek saw 3,455 fishing days from March 1984 to February 1985, which indicates a good fish population (pers. comm. George Holton, DFWP, August 31, 1985).

Hunting is popular in Jefferson County, especially in the Elkhorn Mountains to the east, and to the west of the proposed mine site. DFWP reported in 1983 that over 3,000 deer and elk hunters used hunting districts 318 and 435, south of and including the proposed project area. Ninety-four percent of the hunters using the area were from Montana (project application, 1985). Jim Mitchell of DFWP reports that 101 elk and 291 deer were taken during the regular- and late-season hunts in 1984 in hunting district 435, which includes the project area (pers. comm., September 30, 1985).

Jefferson County offers limited organized recreation. Boulder High School provides interscholastic athletic programs for its students. Boulder youth also participate in summer baseball and softball leagues, and adults enjoy organized basketball, softball, and volleyball. Scouting is available to boys and girls. In addition, Boulder boasts a community library, a senior citizens' center, and a bowling alley.

There are no organized recreational activities in Clancy or Montana City, outside of their school systems.

Lewis and Clark County

Lewis and Clark County includes many designated fishing and camping areas, abundant organized recreation for its residents, and myriad cultural centers.

Most of the fishing access and campground sites in Lewis and Clark County are on the shore of the Missouri River on the county's east side. Eighteen sites along Canyon Ferry Lake (a manmade reservoir of the Missouri River) see the highest volume of visitors of all recreational sites in the county. As an example of the number of visits to the lake, Cave Bay State Recreational Area recorded the most with 86,200 visits during 1983. Fishermen and campers also frequent undeveloped lands along the Missouri River between designated recreational areas (Mountain International, 1984). Recreationists in the Missouri River area enjoy camping, picnicking, fishing, boating, water skiing, swimming, and scuba diving.

Helena provides three libraries, six theaters, three bowling alleys, two golf courses, four health clubs (including the YMCA) a local symphony orchestra and chorus, two community concert series, Carroll College performances, and a city parks and recreation program (including tennis courts, ice skating rinks, and a swimming pool) (project application, 1984). The state capitol hosts many events, including summer tours for tourists, the biennial legislative sessions, and numerous events related to state government.

CULTURAL RESOURCES

The project area is located in the Wickes mining district. Before 1900, the district was one of Montana's most productive mining areas. The Montana Sites Compendium of 1975 designated the Wickes area as a Historic District (see figure III-13). However, the Historic District is not officially recognized by the National Register of Historic Places (NRHP).

The Wickes district was the scene of some of the earliest lode mining in the Montana Territory. Major producers of silver and other metals included the Gregory, Alta, Minah, Washington, and Comet mines. In addition, a number

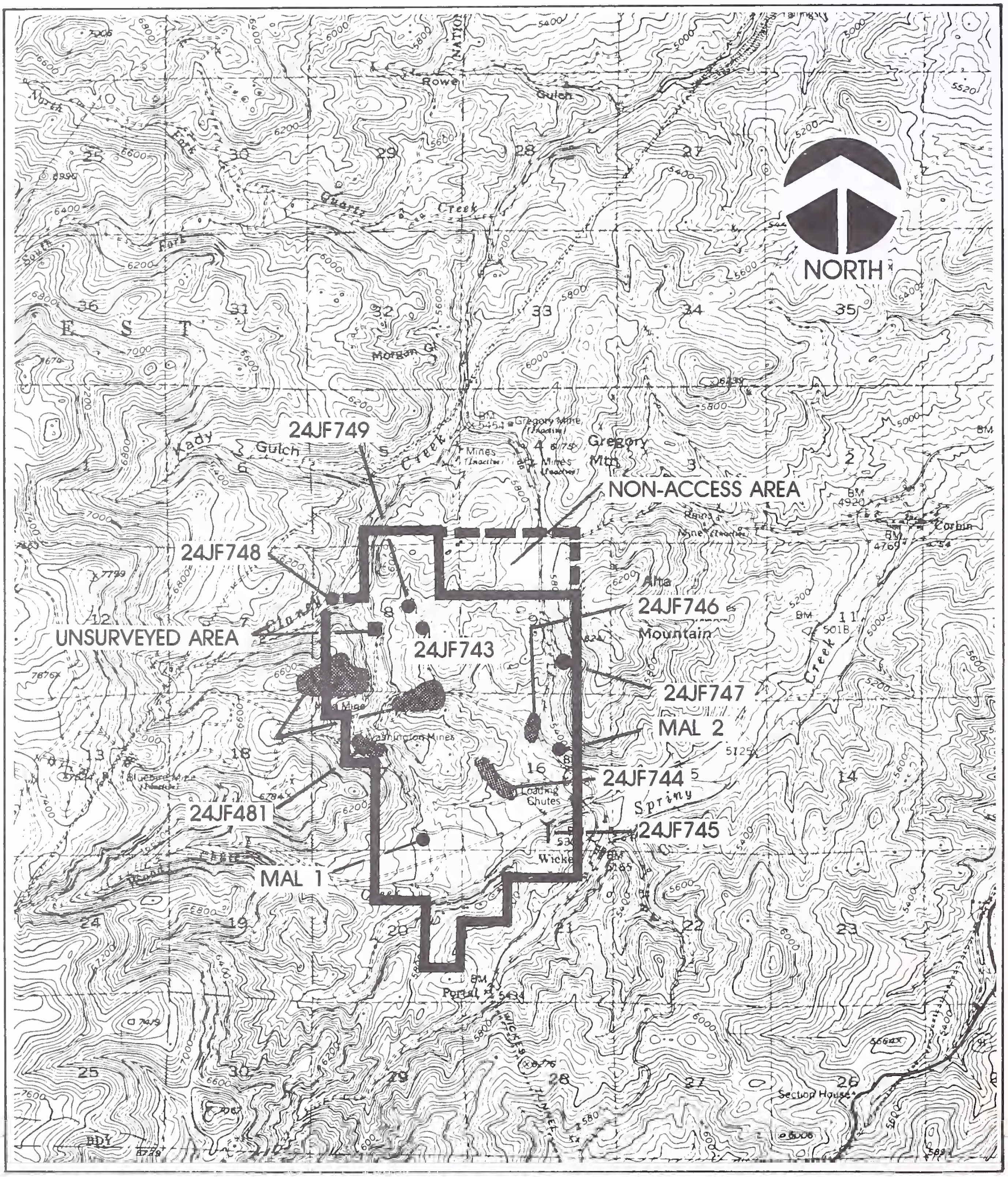


Figure III-13

The project area saw some of the earliest lode mining in the Montana Territory. The Montana Sites Compendium of 1975 designated the Wickes area as a Historic District. Several cultural resource sites were identified within the proposed permit boundary of the project.

of reduction works were built in the area to process the ores. One smelter was built at the Gregory Mine in 1867 and a second in Wickes in 1869. At one time, the Wickes smelter was the largest smelter of its kind in Montana. Two concentrators were also constructed at Corbin to process ore from the Alta Mine. At its peak, the town of Wickes boasted a population of 1,500 people. Many structural remains of the old mines, mills, and smelters can be seen throughout the Wickes mining district.

All historic sites within the Montana Tunnels project area were inventoried by Geological Cultural Management (GCM) Services, Inc. (Anderson et al., 1984). The inventory identified, recorded, and evaluated each site in terms of potential eligibility for listing on the NRHP. Nine sites and two historic loci were recorded in a 4-square-mile area encompassing the project area (see figure III-13). The historic survey by GCM did not include the proposed new county road that would be built on the south side of Alta Mountain.

Two sites, the Washington Mine (24JF481) and Minah Mine (24JF742) have been nominated for listing on the NRHP. All sites within the project area are historic with the exception of the Jas Hill miners' camp (24JF748) which has limited evidence of prehistoric activity.

Site 24JF742

The major structural remains of the Minah Mine are the brick and stone roaster ovens, flue, and stack, which are fairly unique examples of the mining technologies of the 1890s. Most of the mine's original mill and processing buildings are completely destroyed. Overall, the condition of the site is fair to poor.

Site 24J743

The Sites, Dunges, Markin mine/homestead is in poor condition and is not of great historical significance. Remains of the small homestead and possibly mining operation include a log barn with collapsed roof, a chicken coop and log cabin with a low roof. A burned structure, collapsed frame shed and possible mine shaft entrance are also on the site. None of the structures show any special design or construction features.

Site 24JF744

The Van Sickle homestead consists of an old frame house, cement water trough, cement water storage tank, cement basement and foundation for a house, a quartz and cement birdbath, two barns, and an unknown cement structure. The physical condition of the site is poor. The frame house is the only remains of the original homestead. The site has no great historical significance.

Site 24JF745

Remains of the Belle Lode Mine includes a collapsed adit, tramway, and loading chute. Little else remains of the original mining operation. The Belle Lode Mine was not important economically to the mining area.

Site 24JF746

A large log barn with gambrel roof and diamond-shaped window at the top is the most important standing structure on the Freyler homestead. There is also a board shack and a more recently occupied house. The barn and shed are in good condition. The physical integrity of the site has been impaired by the removal or destruction of original structures and the inclusion of modern buildings.

Site 24JF747

Remains of the small Northern Pacific Mine include a collapsed adit portal and a small shed. Below the portal are large areas of tailings. The Northern Pacific Mine was never a major operation nor are there any noteworthy physical remains on the site.

Site 24JF748

No standing structures remain at the Jas Hill miners' camp. A depression near the county road may be a shack or cabin foundation. One basalt flake and one chert biface fragment were observed on the site. The physical integrity of the site is mostly destroyed.

Site 24JF749

Only a partially collapsed log cabin, a partially collapsed adit portal, and tailings piles remain at the Montana Tunnels site. Mining at the site had little local significance. No significant structural remains are found on the site.

Site 24J481

The Washington Mine contains five structures, the remains of the mill, collapsed structures, a portable boiler, tailings piles, and containment dam. The mine was one of the major producers in the region. Many of the structures are collapsed or have been removed.

Sites MAL1 and 2

The two historic loci (minimal activity loci) identified in the project area include a rock cairn and four 1940 car bodies.

A small area of the northeast and northwest portions of the project could not be surveyed because access was denied. The area was, however, examined from the road. The northeast area has low potential for cultural resources. It is mostly cultivated fields. The northwest area has a large, newer, log cabin (the Janet Lyon house), which is not part of the historic activity in the area.

AESTHETICS AND NOISE

Rolling hills, forested mountains, and lush creek bottoms characterize the proposed project area. The vegetation produces variations in landscape patterns, colors, and textures. Few manmade structures occupy the area, but several gravel roads weave throughout the landscape.

Past mining activities have left scattered scars which are visible from Wickes, Corbin, and the roads in the Wickes Mining District. The surface disturbance from the old Alta Mine is visible from Jefferson City and Interstate 15. The entire proposed project area is visible from trails in the Elkhorn Mountains to the east, as well as from Mount Thompson and the Occidental Plateau to the southwest.

Sounds in the area include vehicle traffic on the gravel roads, some livestock, and the elements.

Chapter IV:
Impacts of the Project

GEOLOGY

Impacts Common to Alternatives 1, 2, and 3

Geotechnical Stability

Tailings Dam: The project's tailings impoundment and dam would be stable even if a strong earthquake were to occur nearby (see table IV-1). Based on the methods of dam construction and the rock mechanics properties of the dam material, the dam would have a substantial margin of safety during normal operation. Only during a very strong earthquake would the safety factor drop to 1.0. (Note: a safety factor less than 1.0 means some settlement or movement could occur in the dam.)

The upstream face of the dam would not fail below the tailings level. However, failure above the tailings level during a strong earthquake could occur, but would not endanger the structural integrity of the dam.

Table IV-1: Assessment of Static and Earthquake-Induced Stresses

	Static case (maximum)	Earthquake case (maximum)
Upstream slope	1.4	1.0[1]
Downstream slope	1.75	1.0[2]

[1] The minimum safety factor for the upstream dam face (50 percent slope) of 1.0 is based on the degree of ground shaking that would likely occur during a magnitude 7.0 earthquake (Richter scale) located 20 miles from the site (Bolt and Abrahamson, 1983). (Note: Tailings would gradually be stacked against the upstream face of the dam, increasing the safety factor well above 1.0 over time below the tailings.)

[2] The 1.0 safety factor for the downstream face (40 percent slope) is based on the degree of ground shaking that would likely occur during a magnitude 7.5 earthquake (Richter scale) located 20 miles from the site (Bolt and Abrahamson, 1983).

If an earthquake larger than magnitude 7.5 were to occur--an extremely unlikely prospect for the project area (see Chapter III--Geology)--the downstream face of the dam would remain stable. Settlement of dam material might occur during such an event; however, the internal strength of the dry rockfill dam would remain well above the critical threshold of mass failure. At most, the crest of the dam would drop a few feet during a strong quake. Settlement due to shaking could increase the overall strength of the dam by packing the material tighter together.

The underdrain system at the base of the tailings impoundment would continue to drain the facility--even if the underdrain collection pipes were to break due to differential settlement--because a backup system of relatively coarse-textured material would surround each pipe. As such, water pressures would not be a factor in the stability of the dam and impoundment.

Open-Pit Excavation: The rock composing the pit walls would be strong relative to the soft mineralized core of the ore zone. However, fractures, joints, and faults dissect the entire area and may cause localized slope or bench failures. A geotechnical study (Stiller & Associates, 1985) of the northwest pit wall adjacent to Clancy Creek indicates that stability would be maintained well within engineering standards during normal static loading (periods without motion or change). However, over time, erosional processes of freeze and thaw, wind, and slope failure would smooth the pit walls above the water level and begin to blend it into the surrounding landscape.

Waste Dump: Overall, the reclaimed dumps would be stable. Some minor settlement, rock falls, and slump failures may occur during construction because portions of the waste rock would be dumped at the angle of repose (about 35 degrees). However, such failure would not pose a hazard to the public nor the environment. The waste rock dump faces would be graded to a very stable 40 percent slope angle for the final reclamation.

An assessment was undertaken to determine the geotechnical stability of the waste rock dump under static and severe ground-shaking conditions. A bentonite layer was encountered in one of three backhoe test pits. Assuming that this layer is continuous and located immediately beneath the entire dump--an unlikely prospect--the following safety factors were calculated: 3.0 under static conditions and 1.2 during the strongest earthquake likely to influence the site (Technical Support Document on file at the Montana Department of State Lands in Helena). After final reclamation, the waste rock dump would most likely remain intact even under the most severe conditions.

Geomorphic Stability

Tailings Impoundment: The runoff channel over the impoundment and down the natural hillslope at the western dam abutment would eventually erode and downcut. The greatest channelization would occur on the moderately steep (16 percent) natural hillslope. Over time, flood-flow runoff water would periodically reshape and downcut into the hillside and impoundment, attempting to return it to its original dish-shaped channel gradient.

The process of erosional downcutting would be very gradual, primarily because the drainage area above the dam is fairly small. Peak flood flows would be relatively small (for example, the 100-year, 24-hour flood event would be about 60 cubic feet per second). In an average year, little if any runoff water would flow across the impoundment and dam. Important controlling factors are the physical characteristics of the dam and natural hillslope. The dam would be built of coarse-textured waste rock that would slow runoff waters and dissipate erosional energy. In addition, bedrock under the hillslope buttressing the dam, would help control erosional downcutting.

Shrub and woody vegetation would probably also grow along the channel because of the higher moisture levels. This vegetation would tend to help control channel downcutting.

Sheet, rill, and gully erosion would be minimized for the relatively flat gradient of the impoundment top. However, channelization of the dam abutment and hillside would occur during extreme flood events and would gradually cut back into the flat tailings impoundment. Although channelization and erosion of the impoundment is inevitable, soil formation (see Chapter IV--Soils), vegetative succession, and the natural armoring of coarse material in the channel would promote a reasonably stable postmining geomorphic landscape.

Erosion of the dam face, in general, would be moderate because the length of slope would be relatively short (maximum 750 feet) and the surface would be protected by vegetation and coarse-textured soils (see Chapter IV--Vegetation, Soils). The rate of new soil formation on the face of the dam should eventually equal or exceed the rate of soil erosion. This would promote growth of vegetation and long-term geomorphic stability.

Waste Dump: Despite the rather large size of the proposed waste dump, sheet and rill erosion, gully formation, drainage channel development, and suspended sediment loading of offsite waters would not be excessive during construction nor following reclamation.

After reclamation, runoff from the waste dump would flow directly into the Wood Chute drainage. The amount of sediment reaching the creek would not change significantly as a result of mining-related disturbances. The reason for this is two-fold. First, the 40 percent waste dump slopes would reach an equilibrium between soil erosion, soil formation, and vegetative succession. Second, a majority of the soil eroded off the waste dump would settle on the gently sloping (10 percent) valley bottoms.

Small drainage features may eventually develop on the waste dump where runoff water is concentrated. However, the drainages would not be numerous nor excessively deep; the coarse-textured waste rock at depth would help control channel downcutting.

Impacts Unique to the Proposal (Alternative 1)

Geomorphic Stability

Waste Dump Drainage Diversions: The combined flood flows of Homestake and Pen Yan creeks could cause channel instability in the rerouted channel leading to a small ephemeral channel. Flood flows would deepen and widen the channel, causing gullying and erosion. Bedrock at depth would help control, but not entirely eliminate, the erosion and sedimentation problems over time. The steepened channel would experience measurable erosion during succeeding large flood-flow events.

Impacts Unique to Alternative 2

Alternative 2 geotechnical and geomorphic impacts would be the same as alternative 1, except that Pen Yan Creek would be diverted to the south around the waste rock dump rather than be combined with Homestake Creek and diverted to the unnamed drainage. Downcutting and widening of the unnamed drainage would be minimized under this plan.

Impacts Unique to Alternative 3

Moving the mill facilities to the alternative site would not be significant as far as geotechnical or geomorphic stability; both sites are equally suited for mill site construction.

Impacts Unique to Alternative 4

Under this alternative, no excavation would take place in the project area, so none of the impacts discussed under alternatives 1, 2, and 3 would occur.

HYDROLOGY

Impacts Common to Alternatives 1, 2, and 3

Development of an Open Pit

During the 10-year life of the mine, a large cone-shaped open pit would be excavated in township 7 north, range 4 west, section 8. The pit would be 760 feet deep, with a storage capacity of nearly 46,000 acre-feet.

Development and operation of the proposed open pit would cause the expansion of a drawdown cone of depression similar to that of a large ground water well (see figure IV-1). By the tenth year of mining, the effects of this drawdown cone could extend about one mile. Principles of ground water hydraulics indicate that inflow to the pit is not expected to exceed 250 gallons per minute (Walton, 1970).

Excavation of the pit would physically destroy as many as 10 springs that presently flow for short periods of time during the year. Pit-related dewatering may also reduce the flow of other nearby springs as well as induce seepage from Clancy Creek. Bedrock transmissivities are low and flow rates are small; therefore, the total depletion from Clancy Creek is not predicted to ever be greater than 90 gallons per minute (0.20 cubic feet per second).

The low rate of seepage is supported by the fact that the perimeter of the pit would not intercept Clancy Creek alluvium (Alan Richardson, Vice President of Operations, Centennial Minerals, Inc., pers. comm., February 1985). Furthermore, the applicant has committed to grouting and sealing fractures that might otherwise provide a conduit for larger quantities of flow from Clancy Creek.

As soon as mining operations cease, the pit would begin filling with water. Computer modeling by DSL indicates that after 480 years, water in the pit would be 610 feet deep with a surface area of about 103 acres (see figure IV-2). The pit would not fill completely, but reach an equilibrium between ground water and surface water inflow, evaporation, and ground water outflow. Therefore, no surface discharges are expected in the foreseeable future.

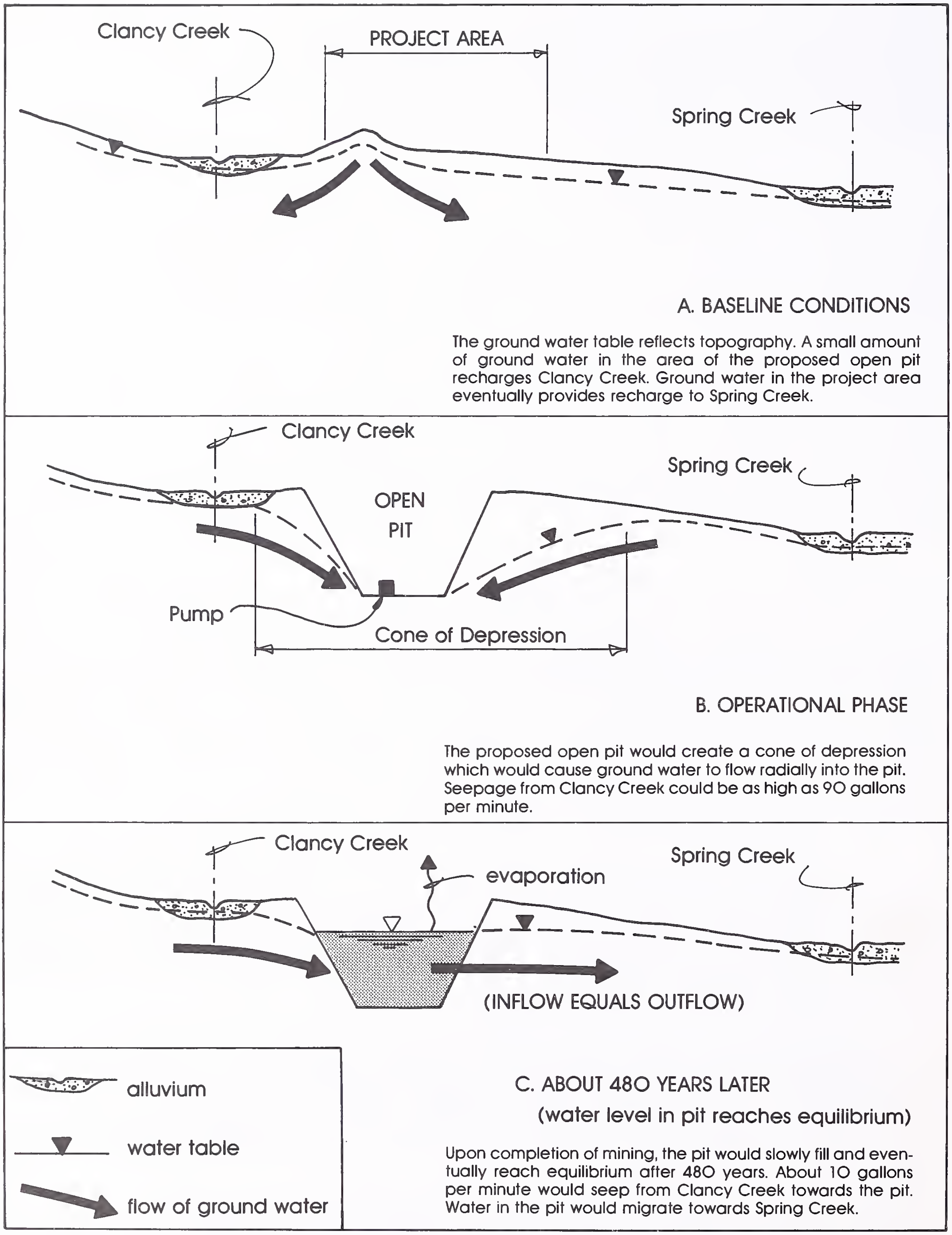
Due to the elevation of the proposed pit rim and expected depth of water at equilibrium, a water table gradient would develop from Clancy Creek southeastward through the pit area and into the Spring Creek drainage. Clancy Creek would become a permanent source of recharge to the Spring Creek ground water system (see figure IV-1). Static flow models suggest long-term recharge from Clancy Creek would most likely be on the order of 10 gallons per minute. This quantity of water would not be available for downstream senior appropriators.

Pit water quality would depend on the wall rock type in contact with pit water. Rain and snow would also come in contact with pit materials. This surface runoff into the pit would affect water quality. The north wall of the 10-year pit would be composed of Lowland Creek volcanics, while the south wall would be in sub-ore-grade diatreme as well as unmineralized diatreme. Several larger quartz-latite porphyry dikes intrude the area of the final pit (see Chapter III--Geology). Chemical analyses were conducted on these rock materials to determine the concentration of trace elements, percentage of sulfur in sulfides, and acid-base balance. While results of chemical analyses presented in table IV-5 cannot be used to accurately predict pit water quality, they do help to provide a framework for the following discussion.

Soon after mining operations cease, diatreme rock--exposed at the lower levels of the pit--would be in contact with air and ground water. Diatreme materials are pyritic and have a sulfide content of several percent. Oxidation of pyrite would cause the initial pit water to be acidic with elevated concentrations of heavy metals. As the pit continued to fill with water, more diatreme would become submerged and the rate of oxidation of pyrite in the deeper sections of the pit would diminish.

As water levels rise, submerged rocks would include increasing quantities of Lowland Creek volcanics that contain lower concentrations of sulfide minerals and metals. In contrast, some diatreme above the waterline would be exposed to rain, snow, and weathering and would have hundreds of years to oxidize. Excavation of the pit would increase the rate of the natural oxidation process.

It would be difficult to accurately predict water quality in the pit at the time it reaches equilibrium. However, the applicant has speculated that the pit would most likely contain acidic water that could be classified as a calcium-magnesium-sulfate type. Concentrations of iron, manganese, and zinc



A. BASELINE CONDITIONS

The ground water table reflects topography. A small amount of ground water in the area of the proposed open pit recharges Clancy Creek. Ground water in the project area eventually provides recharge to Spring Creek.

B. OPERATIONAL PHASE

The proposed open pit would create a cone of depression which would cause ground water to flow radially into the pit. Seepage from Clancy Creek could be as high as 90 gallons per minute.

C. ABOUT 480 YEARS LATER
(water level in pit reaches equilibrium)

Upon completion of mining, the pit would slowly fill and eventually reach equilibrium after 480 years. About 10 gallons per minute would seep from Clancy Creek towards the pit. Water in the pit would migrate towards Spring Creek.

Northeast-Southwest Section

NOT TO SCALE

Figure IV-1

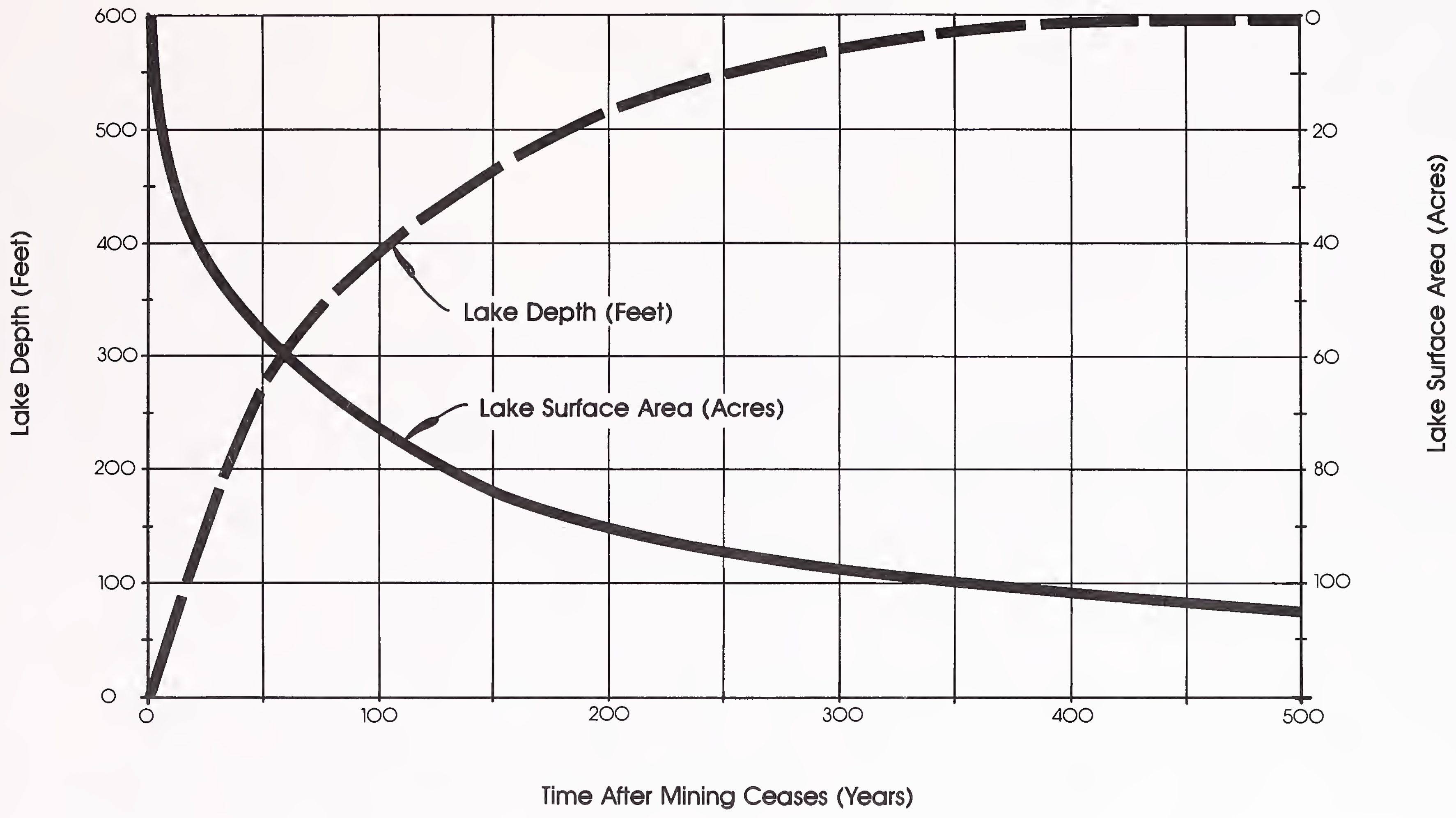


Figure IV-2

After 50 years, water in the pit would be 275 feet deep. Inflow of water to the pit would equal outflow after 480 years.

are expected to range between 0.5 milligrams per liter and several milligrams per liter. Concentrations of aluminum, cadmium, copper, and lead would range between a few hundredths and a few tenths of a milligram per liter (project application, 1984). The project application presents no information which refutes this speculation. In any event, poor-quality water is not expected to seep out of the pit until 480 years later when water levels in the pit reach equilibrium.

Upon reaching equilibrium, pre-mining ground water flow gradients would begin to re-establish and no more than 15 gallons per minute would flow out of the pit towards Spring Creek. The impact of long-term pit seepage on the quality of water in Spring Creek is unknown.

Prickly Pear Creek: The depletion of Spring Creek would also diminish the flow of Prickly Pear Creek and potentially affect downstream senior appropriators. About 192 of the 218 water rights claims on the mainstem of Prickly Pear Creek have a date of priority senior to Centennial Minerals (Montana Department of Natural Resources and Conservation [DNRC], 1985). To supply sufficient water to these existing users, a continuous flow of about 50 cubic feet per second or 2,000 miner's inches is needed (Bill Wagner, Prickly Pear Creek water commissioner, pers. comm., August 21, 1985). In addition, approximately 22 cubic feet per second of municipal and industrial uses have been filed with the DNRC.

A water availability analysis was conducted by DSL to assess this situation. The results of this analysis, presented in table IV-2, indicate that during an average year, the applicant would need sufficient storage for the months of July and August. During the 90th-percentile low-flow, sufficient storage would be required to cover the entire five-month irrigation season. Depending on actual uses during the non-irrigation season, some winter storage may also be necessary. These conclusions assume the new use of Spring Creek would be regulated by a water commissioner. Without regulation, existing downstream senior appropriators could be affected.

The proposed 250 acre-foot water retention pond, if operated at a maximum active storage capacity of 108 acre-feet, would provide a firm supply of makeup water for about four weeks; additional water may be available by draining existing mine workings. During an average year, the project probably could be operated without affecting existing water users. However, during low-flow years an alternative water supply would be needed.

Depletion of flow in Spring Creek is not expected to further degrade water quality in Prickly Pear Creek during base flow conditions. During an average year, the base flow of Prickly Pear Creek near Jefferson City could be reduced about 35 percent. Downstream, at the USGS gauging station, baseflow could be reduced about 10 percent. During spring runoff, impacts to Prickly Pear Creek would not be significantly different than baseline conditions. The most conspicuous problems would continue to be associated with existing mines and disturbances.

Table IV-2: Water Availability Analysis for Prickly Pear Creek Near East Helena

Month	Municipal and industrial water rights	Approximate agricultural consumption	Mean flow supply	90th percentile (low flow) supply	Mean flow availability	90th percentile (low flow) availability
	----------	----------	----------	cubic feet per second	----------	----------
January	22.47	0	20.5	13.0	0	0
February	22.47	0	23.1	16.0	0.63	0
March	22.47	5	29.6	19.6	2.13	0
April	22.47	5	50.4	26.1	22.93	0
May	22.47	50	109.0	62.3	36.53	0
June	22.47	50	133.0	55.7	60.53	0
July	22.47	50	58.8	24.5	0	0
August	22.47	50	30.0	12.8	0	0
September	22.47	5	29.3	14.3	1.83	0
October	22.47	5	30.9	16.8	3.43	0
November	22.47	0	28.4	17.0	5.93	0
December	22.47	0	23.2	15.5	0.73	0

Source: DSL working papers, 1985.

Note: Multiply flow rate by 40 to obtain miner's inches.

Table IV-3: Predicted Impact of Production Wells on the Flow of Surface Water in Spring Creek

Pumping time (days)	Rate of pumping (gpm)	Dewatered reach (miles)
Worst-case analysis:		
30	1,000	0.4
60	1,000	0.6
90	1,000	0.8
120	1,000	1.0
150	1,000	1.0
180	1,000	1.1

Source: DSL working papers, 1985.

Impacts Unique to the Proposal (Alternative 1)

Water Resources Development

Spring Creek: Continuous pumping of ground water in the vicinity of the Munson Ranch in section 11 could dewater Spring Creek upstream of Corbin after five months. Table IV-3 presents the results of the reasonable worst-case analysis (Theis, 1935).

Assuming that surface water supplies are diverted below Corbin, Spring Creek could be dewatered upstream of the confluence with Prickly Pear Creek.

Seven households currently divert surface water from Spring Creek upstream of Corbin for domestic purposes; depletion of Spring Creek above Corbin's water supply could adversely affect these senior appropriators. However, the applicant has committed to ensuring there will not be a disruption of the Corbin water supply. This commitment would be met by providing an alternate water supply if necessary (project application, 1985).

Mineral Processing and Tailings Disposal

Analysis of Seepage from the Tailings Disposal Facility: Seepage from the tailings disposal facility would occur through both the lined and unlined portion of the tailings impoundment as well as through the lined process-water retention pond. It has been calculated that, properly constructed, the proposed tailings impoundment underdrain and liner system would seep about four gallons per minute during the first year of operation. As the area of deposition increases, seepage from the impoundment is expected to reach a maximum of 14 gallons per minute. The theoretical rate of seepage is affected by the degree of consolidation, permeability of tailings and clay liner, the affected area, and the hydraulic gradient; all of which vary through time. The actual seepage rate may also be influenced by the ability to properly key the underdrainage into less permeable bedrock, the capability of the underdrainage to maintain negligible head gradients across the clay liner, geochemical interactions between the tailings effluent and clay liner, and the heterogeneity and fracture variability of foundation materials.

Caustic (high pH) solutions are capable of destroying the integrity of soil bentonite liners. Evidence presented by Morrison (1981) indicates that certain caustics containing 80 percent or more water could completely penetrate an 8-inch compacted bentonite sample in two minutes. Conclusions regarding bentonite liner attack by caustic solutions are also supported by EPA research (U.S. Environmental Protection Agency [EPA], 1982). Because tailings from the proposed project would be deposited in a high pH environment, the bentonite liner may be susceptible to attack. This situation cannot be adequately assessed until further permeability testing with actual tailings effluent is completed. Therefore, the actual seepage rate through the impoundment is unknown.

Water is in short supply; therefore, it is expected that the water retention pond would be operated to maximize available storage. If operated in this fashion, the retention pond would leak about 20 gallons per minute, or about 32 acre-feet per year during each year of the 10-year operation.

The applicant suggests that, properly constructed, the proposed recovery well system would intercept a significant portion of seepage that may move through the base of the impoundment or process-water retention pond. However, Vick (1983) states that the effectiveness of recovery-well systems may be limited in foundations of low or variable permeability such as those encountered in the project area.

The quality of water in the tailings-disposal facility would be a composite of water from the bulk flotation and sulfide milling circuits. The expected quality of water associated with tailings discharged to the tailings disposal facility is presented in table IV-4. Water quality in the process-water retention pond would be affected by the quantity of fresh water, pit water, and existing mine drainage which may also be stored in the retention pond (see Appendix 3). Therefore, as the proportion of water from each source changes, the quality in the retention pond would also change.

Table IV-4: Concentrations of Selected Constituents Found in Tailings Effluent

Element	mg/l	Element	mg/l
Arsenic	0.005	Lead	0.024
Barium	0.018	Mercury	<0.0002
Cadmium	0.0005	Selenium	<0.002
Chromium	<0.005	Silver	0.002
Copper	0.002	Zinc	0.042
Iron	0.22	Cyanide	0.12 to 0.54

Source: Project application, 1984.

Note: Significant concentrations of manganese and aluminum may also be expected based on table IV-5.

Water Quality Impacts

Three potential sources of pollution are poor-quality pit water, impoundment seepage, and seepage from the water retention pond.

The impact on ground and surface water resources from 15 gallons per minute of seepage out of the open pit would not occur for hundreds of years. Ground water resources would not be affected for at least 480 years. Spring Creek surface water resources would not be affected for an even longer period of time. Furthermore, poor-quality water leaving the pit would be diluted and altered by numerous soil-water interactions. Therefore, the impact of long-term pit seepage on the quality of water in Spring Creek is unknown.

A crude estimate of the time required for the alluvium under the tailings impoundment to reach specific retention moisture content indicates that, assuming seepage from the impoundment is limited to 14 gallons per minute, the alluvium could permanently store up to 50 years of seepage. The active mine life is 10 years; therefore, seepage from the impoundment would not be expected to contaminate ground water resources. However, excessive seepage could be detected before it became an environmental concern by monitoring the unsaturated zone below the impoundment.

Seepage from the water retention pond during the 10-year project life is expected to be significant. After reclamation, there may also be a small amount of drainage into the retention pond while the tailings continue to consolidate and drain. Table IV-5 presents the results of the worst-case analysis of the effect seepage from the retention pond would have on Spring Creek. Results indicate that concentrations of arsenic may increase and that total cyanide may approach criteria established to protect cold-water aquatic life (EPA, 1985). Concentrations of heavy metals would also increase. With the exception of cadmium, which already exceeds criteria to protect cold-water aquatic life, predicted metals concentrations would not exceed any other criteria.

Table IV-5: Predicted Impact on Spring Creek Water Quality

Parameter	Detection limit (mg/l)	Criteria[1] (mg/l)	Average baseline concentration (mg/l)	Change (mg/l)	Predicted concentration (mg/l)
Arsenic	0.001	0.0	0.014	+0.00005	0.01405
Cadmium	0.001	0.0018	0.002	+0.000005	0.002005
Copper	0.01	0.02	0.03	+0.00002	0.03002
Cyanide	0.001	0.0052	<0.01	+0.0054	0.0054
Iron	0.01	0.30	<0.03	+0.0022	0.0022
Lead	0.05	0.007	0.02	+0.00024	0.02024
Zinc	0.005	0.047	0.1	+0.00042	0.10042

Source: DSL working papers, 1985.

Note: EPA cold-water criteria for aquatic life for arsenic is 0.19 mg/l. Manganese concentrations could not be quantified without additional data.

Assumptions: direct mass balance approach--no chemical attenuation, flow in Spring Creek = 1000 gpm, seepage from retention pond = 20 gpm, initial concentrations based on tailings effluent chemistry, 50 percent recovery well efficiency.

[1] Drinking water criteria for arsenic. Cold water aquatic criteria for other parameters.

Seepage from the water retention pond could enter the ground water system about the fifth year of operation and continue for another 5 or 10 years. Assuming a fractured bedrock permeability of 1.40 feet per day, gradient of 0.07, and porosity of 0.05, a contaminant plume could reach Spring Creek alluvium soon after mine closure and persist for about 5 or 10 years. For a discussion of the physical characteristics, toxicity, and fate of cyanide in the environment, see Appendix 4.

Impacts Unique to Alternatives 2 and 3

There are no hydrologic impacts unique to alternative 2 or 3. Under these alternatives, seepage from the process water retention pond would be reduced substantially by a synthetic liner; therefore, Spring Creek water quality would not be affected. The applicant would design a process-water retention pond with sufficient storage capacity, or purchase additional downstream senior water rights; therefore, existing water users who have water rights with an earlier date of priority than the applicant would be protected during periods of low flow. All other pit-related impacts, discussed earlier, would still occur under these alternatives.

Impacts Unique to Alternative 4

Under alternative 4, none of the hydrology impacts discussed for alternatives 1, 2, or 3 would occur.

AQUATICS

Impacts Common to Alternatives 1, 2, and 3

Macroinvertebrates and diatoms in Clancy Creek would not be affected by alternatives 1, 2, or 3. Seepage from Clancy Creek into the open pit would not noticeably reduce flows or available habitat downstream in Clancy Creek. Predicted stream depletion would never be greater than 90 gpm, and would eventually stabilize at 10 gpm once the pit filled. Pit seepage would be toward Spring Creek rather than toward Clancy Creek. Thus, Clancy Creek water quality would not be affected by seepage from the pit. Clancy Creek would continue to support high diversities of aquatic organisms.

Seepage from the tailings impoundment would not affect macroinvertebrates or diatoms in Spring Creek. Seepage from the impoundment would be retained by the underlying unsaturated alluvium and would not reach Spring Creek. Depletion of Spring Creek would adversely affect aquatic communities in lower Spring Creek, although diversities are already very poor. Dewatering of Spring Creek may also adversely affect the aquatic community in Prickly Pear Creek downstream of Spring Creek. Although depletion of flow in Spring Creek is not expected to degrade water quality in Prickly Pear Creek, during an average year the base flow near Jefferson City could be reduced up to 35 percent. The reduced flow could further reduce abundance and diversities of aquatic communities in Prickly Pear Creek below Jefferson City.

Impacts Unique to the Proposal (Alternative 1)

Streamflow depletion (assuming total depletion) in Spring Creek for mine-process water (see Chapter IV--Hydrology) could reduce or destroy macroinvertebrate and diatom communities or reduce their diversities in Spring Creek above Corbin. After mining, flows in Spring Creek would return; however, seepage from the water retention pond could introduce cyanide. The concentrations of cyanide in Spring Creek may approach the criteria established to protect cold-water aquatic life. Thus, seepage from the retention pond could prevent macroinvertebrates and diatoms from recolonizing Spring Creek for a period of 5 or 10 years following reestablishment of surface flow.

Impacts Unique to Alternative 2

Impacts caused by streamflow depletions in Spring Creek above Corbin would not occur under this alternative.

There are no impacts unique to this alternative.

Impacts Unique to Alternative 3

Relocation of the plant facilities would not affect streamflows in water quality.

There are no impacts unique to this alternative.

Impacts Unique to Alternative 4

Aquatic organisms in Spring Creek may eventually be affected by the contaminant plume from the Washington and Minah mines.

FISHERIES

Impacts Common to Alternatives 1, 2, and 3

The slight reduction in Clancy Creek streamflow (see Chapter IV--Hydrology) would not affect the creek's trout population. Water quality in the creek would not be changed.

Trout in Prickly Pear Creek would not be harmed by a reduction in streamflow. This reduction would result from dewatering Spring Creek, a tributary of Prickly Pear Creek, to obtain mine-process water. A 35-percent decrease in flow has been predicted for Prickly Pear Creek near Jefferson City. However, this segment of the stream supports only a highly mobile trout population that may not be present year-round. Significant impacts to fish are not expected. Further downstream, where resident fish populations do exist, the slight reduction in flow would not harm fish. Water quality of Prickly Pear Creek would not be degraded.

Impacts Unique to the Proposal (Alternative 1)

While the mine operates, the dewatering of Spring Creek (see Chapter IV--Hydrology) could remove trout habitat in section 11. Most of the population could be destroyed although some trout may move downstream. These trout, however, would encounter poor-quality water or inadequate water supply. Their survival would be doubtful. After mining, Spring Creek would flow again; however, water quality may be insufficient for trout repopulation for 5 to 10 years. Cyanide from the retention pond would reach Spring Creek after mine closure. Elevated cyanide levels would continue for an estimated five years. Cyanide concentrations (table IV-5), may approach criteria established to protect cold-water aquatic life (U.S. Environmental Protection Agency, 1985).

Impacts Unique to Alternative 2

Mitigating measures required under this alternative would protect the Spring Creek trout population and reduce water quality degradation.

Impacts Unique to Alternative 3

Relocating the facilities site would not affect fish populations. The impact analysis is identical to the analysis for alternative 2.

Impacts Unique to Alternative 4

Under this alternative, mining activities would not affect fish. However, fish in Spring Creek may eventually be affected by the contaminant plume from the Washington and Minah mines. The impact of degraded water from Spring Creek entering Prickly Pear Creek is unknown.

SOILS

Impacts Common to Alternatives 1, 2, and 3

Unavoidable Soil Impacts

Some impacts on soils at the proposed minesite would be unavoidable. As a result, the reclaimed lands would probably be more sensitive to mismanagement and drought than before disturbance. Natural soil development processes would eventually correct these impacts.

The unavoidable soil impacts, typical of any operation where soil is removed, stored, and replaced, include a decrease in infiltration and percolation rates, which increases runoff and erosion. These impacts are the result of the loss of the natural soil profile, pore space continuity, reduction in overall pore space, a breakdown of soil structure, and a loss of organic matter due to dilution with mineral soil (during handling) and decomposition (in the stockpiles).

Biological soil impacts would occur in most of the salvaged soils. These impacts, for the most part, are also unavoidable. Because most of the disturbances (such as the tailings impoundment, facilities area, haul roads, and parts of the waste rock dump) could not be reclaimed until the end of the mining operation, it would be necessary to stockpile about 75 percent of the soils salvaged from these areas. This soil would remain in the stockpiles for at least 10 or 11 years.

Prolonged storage deteriorates the soil biologically. Storage decreases the populations of, or eliminates, important soil microorganisms such as bacteria, fungi, and algae which are essential in soil nutrient cycling (Miller and Cameron, 1976). In addition, some favorable components normally found in natural soils are lost through decomposition during storage. These components include seeds of native plants, rhizomes (underground stems), and other plant parts capable of producing new plants. Mycorrhizae--important structures that develop when certain fungi and plant roots form a mutually beneficial relationship--are also eliminated in soil stored for prolonged periods. Mycorrhizae serve as highly efficient extensions of plant root systems, and are important to consider in maximizing plant productivity since most plants depend on mycorrhizae for adequate growth and survival (Malloch et al., 1980; Trappe, 1981). These structures are particularly important to plant phosphorus nutrition and water uptake (Christensen and Allen, 1980). Thus, the association of mycorrhizae with plants in the project area is especially critical since plant-available phosphorus and effective precipitation are low.

The loss of mycorrhizae could lower plant species diversity on the reclaimed lands (Reeves et al., 1979). Mycorrhizae would invade reclaimed sites from adjacent, undisturbed areas and species diversity would eventually increase. No large-scale field method exists for the artificial establishment of mycorrhizae in soils of disturbed sites.

The biological impacts discussed above would not occur in the remaining 25 percent of the soil because it would not be stored. This soil would be hauled directly from newly disturbed areas to portions of the waste rock dump that have been graded and are ready to be reclaimed. The important soil organisms, native seed, and other plant parts would be transported with the soil directly to these reclamation areas.

Soil Erosion

Soil erosion is likely to occur on the waste rock dump slopes, tailings impoundment dam, and mine road cut-and-fill slopes during the first several years following soil replacement and seeding. However, initial erosion rates are expected to be moderate to low, and would decrease significantly as vegetation becomes established. The applicant's proposed erosion-control measures (see Chapter II) and the coarse texture and coarse fragment content of the soils would help keep erosion rates at tolerable levels until the slopes are stabilized by the new vegetation. After vegetation is reestablished, however, erosion rates would probably be slightly higher than before disturbance for an unknown period of time. This would be due to the unavoidable soil impacts discussed earlier in this section.

Postmining Soil Water and Nutrient Status: Postmining water- and nutrient-holding capacities of soil would be low due to the dilution or loss of organic matter (caused by soil handling and storage) and the coarse nature of the soils in the proposed disturbance area (table II-6). This would be particularly true in soils that have been stored in stockpiles for the life of the operation. The low water-holding capacity would be especially detrimental to plant growth in the Montana Tunnels project area where effective precipitation is relatively low. Although the applicant would apply fertilizer to the respread soils, the nutrients that are not used by the plants within the first few growing seasons would probably be leached out of the rootzone, because the soils would not have enough capacity to retain these nutrients.

The expected low water- and nutrient-holding capacities of the postmining soils would probably lead to a vegetative cover less dense than existed before disturbance. With time, the litter produced by the plants that grow on the reclaimed areas would be incorporated into the soil, and water- and nutrient-holding capacities would eventually increase; subsequently, vegetative cover would also increase.

Impacts Unique to the Proposal (Alternative 1)

Tailings Impoundment

As discussed in Chapter II, about 17 inches of soil would be available to cover all of the disturbance areas including the tailings impoundment (see Chapter II, table II-5.) If the tailings contained only innocuous materials, the proposed soil replacement depth would be adequate for successful reclamation. However, the two types of tailings that would be produced would have a net acid-generating potential, even after they are mixed (see table IV-6). The sulfides in the tailings would oxidize and form sulfuric acid. At the surface of the tailings (beneath the replaced soils), acid generation would occur relatively rapidly due to the availability of oxygen and the large surface area of the silt- and clay-sized tailings particles.

A good potential exists for the overlying soils to become acidified over time. Based on research by Barth and Martin (1982, pages 39-49), acidification could occur in the lower part of the soil layer after about five years. Acidification of the entire 17-inch soil layer could occur within 20 to 50 years. This assumption is based on the rate of acidification reported in the Barth and Martin (1982) study. The upward migration of acid could stop at any depth, owing to a number of environmental factors, such as a precipitation/evaporation equilibrium. However, if the acid continues to move upward and further contaminates the soil layer, plant growth would be adversely affected. This increase in acidity (decrease in pH) eventually would interfere with plant growth. As the acidity of the tailings and overlying soil increases, the mobility and plant availability of many of the trace elements would also increase. Some trace elements, such as cadmium and zinc, could reach concentrations that would also be detrimental to plants.

Because soil acidification could occur over time, the effects of this on plants may not be noticeable or measurable for 10 years or more. Therefore, after the first few years of vegetation establishment, the resulting plant cover would probably appear to be adequate to meet the objectives of the reclamation plan. However, with time, a decrease in plant vigor and an increase in plant mortality would probably occur if the soils became more acidified and otherwise contaminated by some of the trace elements. In a worst-case scenario, most or all of the vegetation on the surface of the tailings impoundment could fail after many decades. This, in turn, would result in progressively increasing erosion rates on the surface of the impoundment.

The applicant proposes to establish a research demonstration area on a portion of the tailings impoundment with the intention of studying vegetative growth and determining whether it is necessary to place a waste rock cap over the tailings before soil redistribution (see Chapter II). However, it would only be possible to monitor the demonstration area for about five years. Because plant growth would probably not reflect the effects of soil acidification and contamination within this time period, it would likely be determined that it is not necessary to cap the tailings with waste rock.

Table IV-6: Characteristics of Montana Tunnels Ore and Waste Materials

Material	Volume (mcy)[1]	Texture	Cadmium	Nickel	Zinc	Lead	Copper	Manganese	Mercury	Arsenic	Aluminum	Selenium	Sulfide sulfur	Acid generation potential[2]	Neutralization potential[3]	Acid-base balance[4]
			-------	-------	-------	-------	-------	parts per million	-------	-------	-------	-------	(percent)			
Ore Type[5]																
Diatreme ore (bulk composite)	--	--	80	50	9,600	3,000	600	270	0.6	46.0	77,700	--	--	--	--	--
Waste Rock Types[6]																
Quartz latite dike	12.0	very cobbly, sandy loam	0.017	0.05	0.46	0.14	0.07	51.40	<0.0001	<0.005	<0.1	0.001	0.27	8.4	57.1	+48.7
Sub-ore grade diatreme	30.0	very cobbly, sandy loam	0.021	0.02	5.80	17.20	0.05	18.10	<0.0001	<0.005	1.2	<0.001	1.19	37.2	15.5	-21.7
Lowland Creek volcanics	71.0	very stony, cobbly, sandy loam	0.015	0.03	3.77	0.03	0.04	4.28	<0.0001	<0.005	0.1	<0.001	0.10	3.1	8.1	+5.0
Elkhorn Mountain volcanics	5.9	very stony, cobbly, sandy loam	0.013	0.05	0.22	0.17	0.07	4.82	<0.0001	<0.005	0.2	<0.001	0.08	2.5	12.0	+9.5
Tailings Types[6]																
Bulk flotation tailings	7.8	very silty or clayey	0.930	0.05	1.95	0.12	0.08	0.80	<0.0001	<0.005	0.1	<0.001	0.18	5.6	1.9	-3.7
Sulfide tailings	0.9	very silty or clayey	3.480	0.12	63.90	6.03	0.04	3.13	<0.0001	<0.005	<0.1	<0.001	35.20	1,099	0	-1,099

Source: Montana Tunnels permit application, 1984.

[1] million cubic yards

[2] Presented as tons of calcium carbonate equivalent (required to neutralize the acid) per 1,000 tons of waste material.

[3] Presented as tons of calcium carbonate equivalent per 1,000 tons of waste material.

[4] This is the difference between the acid generation potential and the neutralization potential. A "+" indicates a net neutralization potential, whereas a "-" indicates a net acid-producing potential.

[5] Ore values presented are total concentrations.

[6] Arsenic, aluminum, and selenium were extracted using hot water with a 1:5 solids-to-liquid ratio. The remaining trace elements were extracted using a weak acid (EP Toxicity) with a 1:20 solids-to-liquid ratio. Sulfide sulfur was determined using a LECO furnace.

Impacts Unique to Alternative 2

There are no impacts unique to alternative 2. Under this alternative, no soil acidification or contamination would occur on the surface of the tailings impoundment because the tailings would be capped with innocuous waste rock before soil redistribution. All other soil impacts, discussed earlier, would still occur under this alternative.

Impacts Unique to Alternative 3

There are no impacts unique to alternative 3. Soil characteristics and recommended salvage depths for the alternate facilities site are similar to those for the proposed site. The soil impacts of this alternative would be the same as those discussed for alternative 2.

Impacts Unique to Alternative 4

Under alternative 4, none of the soil impacts discussed for alternatives 1, 2, or 3 would occur.

VEGETATION

Impacts Common to Alternatives 1, 2, and 3

Mining would destroy 932 acres of existing vegetation. Over 80 percent of the affected vegetation would be made up of grassland and Douglas-fir forest (figure IV-3). In addition, 33 acres of previously disturbed would be removed.

Final Revegetation

Mining and reclamation would significantly change the proportions of vegetation types in the disturbance area (figure IV-3). The pit would cause the most significant impact on vegetation; it would create 162 acres of disturbed and essentially barren land. Vegetation in the pit would be limited to sparsely scattered trees and shrubs that develop from the Douglas-fir seed mixture. As soils form, more plants would become established. However, soil formation is so extremely slow that the pit must be considered devoid of vegetation. The increase in post-mining shrub/grassland acreage, together with the area lost to the pit, would cause a reduction in grassland and forest (figure IV-3). For example, revegetation would reduce the acreage of aspen from 21 to 7. Cropland and previously disturbed lands would be converted to other types during reclamation.

Topsoil used during reclamation is expected to be low in water- and nutrient-holding capacity (see Chapter IV--Soils), a characteristic that would limit the establishment of seeded species. Initial ground cover would, therefore, be sparse with scattered patches of bare soil. Over time, vegetation would increase as organic matter is incorporated into the soil. The seeded

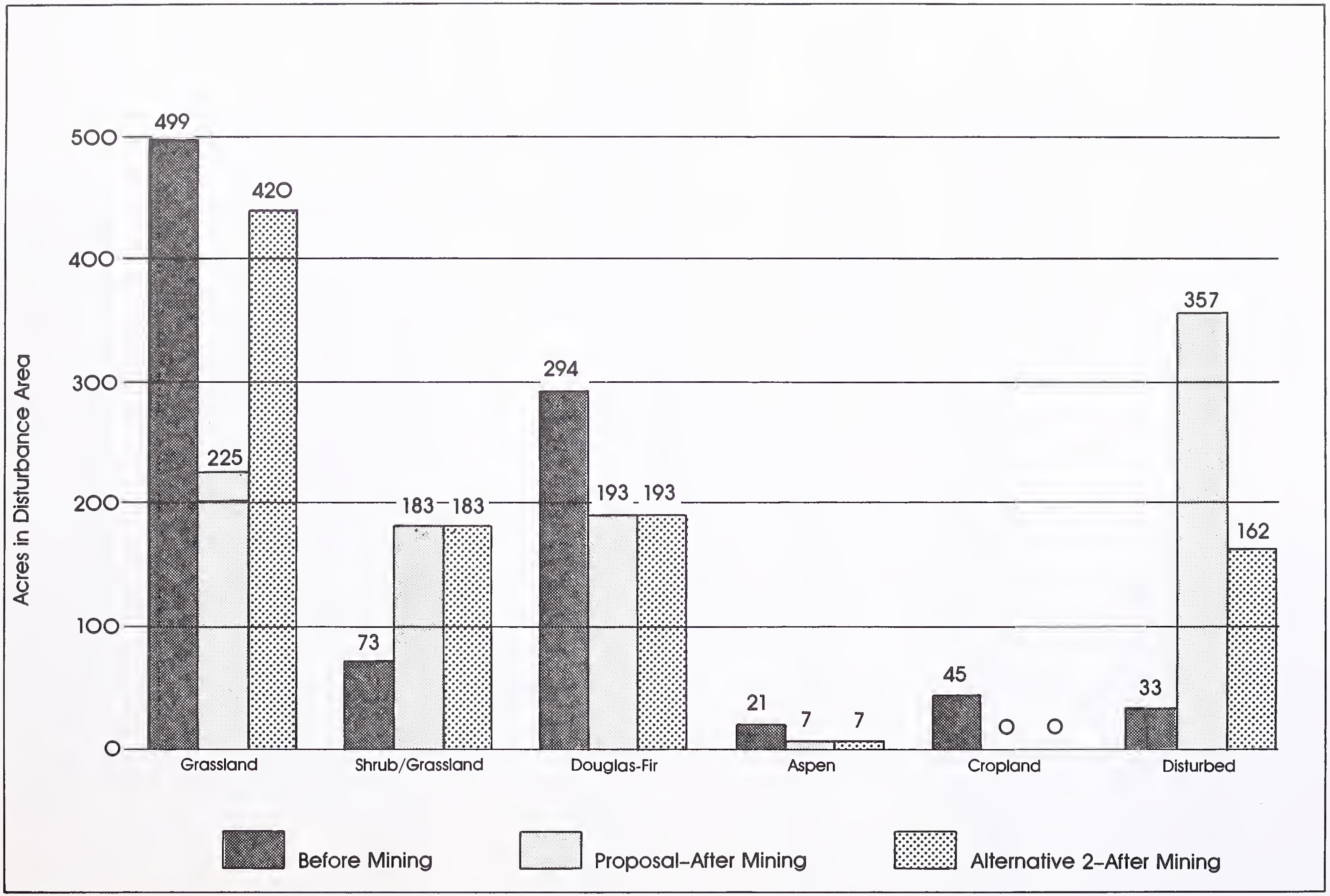


Figure IV-3

The increase in shrub/grassland and permanently disturbed area would significantly change the vegetational composition of the proposed permit area. The disturbed category (after mining) includes the pit. Proposed acreages are based on the assumption that grassland on the tailings impoundment would fail.

species are generally well-adapted to the Montana Tunnels area and seeding rates appear to be appropriate. The eventual establishment of an erosion-controlling ground cover over most revegetated areas is anticipated. The steep slopes of the dam face would probably experience the most erosion problems.

After vegetation becomes established, plant production (biomass/unit area/unit time) would approach and could exceed premining levels. Long-term production would probably be similar to baseline production. However, total plant biomass in the disturbance area would be lowered due to the loss of potentially productive lands to the pit.

Revegetation types would have lower plant diversity than their corresponding premining types. The number of species proposed for seeding is far below the number of species recorded during baseline surveys (table II-7, table II-8, and table III-6). Furthermore, the seeds and plant parts that could add more species would not be available in the stored topsoil (see Chapter IV--Soils).

Plant diversity would slowly increase as plants invade from adjacent, undisturbed areas. This invasion process, however, would require a lengthy period of time to affect the centers of large disturbance areas. Another potential source of new species may be the seeds contained in the straw mulch. However, these seeds may develop into weeds that would compete with the more desirable plants for water and nutrients. The applicant could limit the negative effects of weeds by using a clean (relatively free of weed seeds) mulch or controlling weeds as they develop.

Woody Species

Shrub densities in the postmining environment would be far below the densities that existed before mining (table III-7). Reductions in densities of major species--bitterbrush, rose, serviceberry, and raspberry--would be most noticeable. Decreased density would be due primarily to the proposed planting rates (table II-9). After planting, mortality would further reduce the number of seedlings. Published research suggests that mortality rates could be in the vicinity of 20 percent on bitterbrush, 18 to 28 percent on Wood's rose, 11 to 54 percent on serviceberry, and 8 to 25 percent on snowberry (Howard et al., 1979; Everett, 1980; Fedkenheuer et al., 1980; Hungerford, 1984). The applicant's commitment to control competing herbaceous plants would improve survival.

Big sagebrush, white spirea, currant, and maple would not be present following reclamation. These species may eventually appear when shrubs from adjacent, undisturbed lands invade revegetated areas. This slow shrub invasion may also increase the densities of planted species. Also, surviving planted shrubs would spread by root sprouting or seed dissemination.

For the first few years of reclamation, densities of planted conifers would be lower than the densities found in premining forests. This initial decrease would be due to planting rates (table II-9) and seedling mortality. Mortality of Douglas-fir seedlings could range from 5 percent to 58 percent

(Hite, 1974; Kittams and Ryker, 1975; Noble et al., 1978; Stein, 1984; Strothmann and Roy, 1984). A rate of 50 percent appears to be a reasonable estimate of mortality (Hall, 1971). Although Douglas-fir seeds (table II-8) could add to the density, Strothmann and Roy (1984) state that the probability of seeding failure is comparatively high. Lodgepole pine, the other planted conifer, would probably exhibit better survival than Douglas-fir.

Seeds from undisturbed conifers would fall into the edges of reclaimed areas. The resulting regeneration process would slowly proceed inward and would eventually increase conifer density. Seeds from planted conifers would also add to long-term density. Several decades would pass before tree heights reached the heights found in premining forests.

Aspen density in the seven acres of reclaimed aspen forest would be lower initially than premining density. Aspen would, however, achieve premining densities with sprouts and seeds from planted trees. Williams and Johnston (1984) found that aspen seeds could germinate and survive on mined lands in Idaho. Many years would be required for premining tree heights to be attained.

Developing trees and shrubs would be subject to damage by livestock and wildlife. The plan to prohibit livestock from reclaimed lands for two years would protect most woody plants. The measures proposed to control wildlife damage, however, would be less effective. Although damage by wildlife (such as mule deer, elk, and rodents) could be significant, the magnitude of the problem cannot be predicted.

Interim Revegetation

Plant diversity on the reclaimed waste rock dumps would be higher than diversity found in other reclaimed areas. This characteristic would be due to the use of directly hauled soils which contain seeds and other regenerative parts of native plants. The application of hydromulch could not eliminate erosion on the dump's steep slopes. Some erosion would also occur on the dam face and soil stockpiles despite the use of hydromulch and rapidly developing species (table II-3). This erosion, however, would probably be limited to small, local areas.

Impacts Unique to the Proposal (Alternative 1)

The potential acidification of soil overlying the tailings (see Chapter IV--Soils) could affect 195 acres of revegetated grassland. Plants growing in the acidic soil would begin to lose vigor after roughly 10 years. Increased availability of cadmium and zinc (see Chapter IV--Soils) would also lower vigor. Subsequent plant mortality would result in patches of barren soil. In time, all of the reestablished grassland on the tailings site could fail. This failure would reduce postmining grassland to 225 acres while creating a 357-acre (162-acre pit and 195-acre tailings site), permanently disturbed area (figure IV-3).

Conifer density in reestablished forests would be substantially lower than the density found in premining forests. This decrease, due to proposed planting rates, subsequent mortality, and potential seeding failure, would persist for many years.

Impacts Unique to Alternative 2

There are no impacts unique to alternative 2. Required mitigating measures would help to insure that soil on the tailings site is not acidified and that reestablished Douglas-fir forests contain a density of conifers comparable to premining density. All other vegetation impacts discussed under Impacts Common to Alternatives 1, 2, and 3 would still occur.

Impacts Unique to Alternative 3

Relocating the facilities site would insignificantly affect the acreages of vegetation types disturbed. Revegetation methods and success would be similar to those mentioned for alternative 2.

Impacts Unique to Alternative 4

Under alternative 4, none of the vegetation effects discussed for alternatives 1, 2, or 3 would occur.

WILDLIFE

Impacts Common to Alternative 1, 2, and 3

Impacts to wildlife can be classified as direct or indirect. Direct impacts from mining would include habitat loss and subsequent displacement of wildlife, creation of different habitats during reclamation, destruction of relatively nonmobile populations, and disturbance of nearby wildlife by mining activities. Indirect impacts include collisions between vehicles and wildlife (road kills) and effects caused by more people using wildlife ranges.

Elk and mule deer can be observed in the study area during any season. Elk use peaks in the winter while most deer are observed in the summer. The amount and quality of winter forage often limits elk and deer herd sizes (Mautz, 1978). Wintering elk and mule deer, reacting to excessive human disturbance, could deplete all the energy found in forage or body reserves. The resulting absence of energy necessary for reproduction would lead to declines in population size. Excessive disturbance can also be harmful during other seasons by decreasing the body reserves that determine winter health and reproduction.

Direct Impacts

Wildlife Habitats: Mining would remove 932 acres of existing wildlife habitat along with 33 acres of previously developed land. Grasslands would account for about 54 percent while Douglas-fir forests make up about 32 percent of the affected habitats (table III-8 and figure IV-3). Grasslands and Douglas-fir habitats are inhabited by a variety of species ranging from black bear to mountain chickadee. These two habitats are particularly important to elk and mule deer. However, the amount of these forests and grasslands removed by mining represent only a small portion of available habitats (table III-8). Animals displaced by habitat loss could move into nearby, abundant habitats.

Displaced wildlife would compete for resources with animals already residing in adjacent habitats. If resident populations are at carrying capacity, the addition of more animals would result in an overall population decline. However, carrying capacities of surrounding habitats are difficult to measure and the magnitude of population changes cannot be predicted.

Much of the disturbance area could not be used by wildlife until reclamation is complete--at least 12 years after mining begins. However, the 421-acre waste rock dump would be revegetated during mining. Some animals may habituate to mining activities and forage on the reclaimed dump. Other foraging habitats could be supplied by areas seeded with interim revegetation mixtures (table II-3). Although the presence of nitrogen-fertilized plants may encourage occasional foraging, overall wildlife use would be kept low by human activities and the expanse of disturbed lands.

Final revegetation would establish herbaceous plants to provide forage for wildlife. Small mammals would also find cover beneath the seeded species. Cover and browse availability for larger animals, however, would be low until woody species mature.

The proportions of wildlife habitat types in the postmining environment would differ from the premining proportions (figure IV-3). The amounts of grassland and Douglas-fir forest would decline and shrub-grassland acreage would increase. This change would reduce forage and cover for most wildlife species. Mule deer, however, would find more foraging habitat in newly established shrubfields. The major cause of the proportional change is the 162-acre open pit. Even over the long term, this unreclaimable feature would have little value to wildlife.

Elk: Direct destruction of winter range by mining would not have significant impacts on elk. Only small portions of the Washington Hill concentration area would be removed (figure III-9). The activity associated with mining would cause greater range loss than would physical habitat removal. Elk would probably respond to mining by withdrawing to the west. Areas with substantial human influences are avoided initially by elk (Knight, 1980; Ward, 1976; Irwin and Peek, 1983; Ferguson and Keith, 1979). The distance of the elk movement cannot be precisely predicted; however, published research (table IV-7) suggests that 1/2 mile is a reasonable estimate of withdrawal distance. Regardless of the distance, areas with visual barriers separating elk from the mine would receive the most use (Montana Cooperative Elk-Logging Study, 1976; Olson, 1983; Ward, 1985).

After the initial withdrawal, elk may eventually use habitats next to the mine. Return to these adjacent areas would follow habituation to mining

Table IV-7: Influence of Roads and Human Activities on Elk

Human influence	Upper limit of influence	Elk response within upper limit	References
Moving automobile	0.1 mile	Increased heart rate	Ward and Cupal, 1979
Stopped automobile	0.3 mile	Increased heart rate	Ward and Cupal, 1979
People on foot	0.2 mile	Increased heart rate	Ward and Cupal, 1979
People on foot	0.5 mile	Avoidance of people	Ward, 1976, 1985; Ward et al. 1976
Seismic exploration	0.6 mile	Increased daily movements	Knight, 1980
Roads	0.125 mile	Avoidance of roads	Rost and Bailey, 1979
Roads	0.25 mile	Avoidance of roads	Hershey and Leege, 1976; Irwin and Peek, 1983
Roads	0.5 mile	Avoidance of roads	Perry and Overly, 1976, 1977
Roads	1.2 mile	Avoidance of roads	Morgantini and Hudson, 1979
Logging	4.0 mile	Displacement	Montana Elk-Logging Study, 1976

activity. Elk habituation to human presence has been noted by Ward et al (1976), Schultz and Bailey (1978), Knight (1980), and Ferguson and Keith (1982). However, habituation would depend on non-threatening behavior by humans (Geist, 1971). Thus, non-mining activities, such as hunting or harassment, could interfere with the habituation process.

Elk using ranges in the vicinity of the mine may exhibit altered behavior. Behavioral changes in response to human activity has been reported in other instances. Elk became more nocturnal and used habitats with heavy cover to avoid humans (Geist, 1971; Schultz and Bailey, 1978; Morgantini and Hanson, 1979). Elk group sizes may also decrease. Westech (1984) suggested that hunting may have lowered elk group sizes near Gardiner, Montana. Cameron et al. (1979) noted a similar decline in group sizes of caribou during construction of the Alaska pipeline. Use of habitats with dense cover and reduced group size has a potential to negatively affect elk. Intake of high-quality forage and foraging efficiency could decrease (Morgantini and Hudson, 1985; Geist, 1982). If these reductions are excessive, elk populations could be negatively affected during severe winters.

The travel route between the Gregory Mountain and Washington Hill concentration areas would be blocked by the open pit. Elk would probably adjust to this barrier by selecting alternate routes. Adams (1982) noted that elk will shift to alternative routes when traditional routes become unavailable.

Traffic on mine-access roads would not affect elk range use or habitat use. The roads neither penetrate nor adjoin elk range (figure III-9).

After the mine closes, elk could return to original ranges and could expand their range to include the reclaimed permit area. However, postmining environment would have less grassland and Douglas-fir forest than existed before mining. Thus, the quality of potential elk habitat within the permit area would be lowered. A decline in potential habitat would not, however, significantly affect elk populations.

Mule Deer: The disturbance area falls within mule deer summer range (figure III-8). The scattered nature of observations made the delineation of summer range unfeasible. Thus, the proportion of range lost to the 965-acre disturbance area cannot be determined. No obvious summer concentration areas would be affected.

Mule deer would react to range destruction by moving into surrounding summer range. Summering areas available to deer are generally abundant due to absence of snow.

Mule deer may be further displaced by the noise and activity of mining. Avoidance reactions by deer would be less pronounced than reactions by elk. Mule deer security requirements are substantially less than those of elk (Lyon and Jensen, 1980). Studies on deer response to roads (Rost and Bailey, 1974; Perry and Overly, 1977) suggest that deer use would decrease in all areas within 1/8 mile of mining.

Displacement due to range destruction and mining activity would also affect wintering mule deer. A large portion of the disturbance area lies within the winter range subjectively identified by area residents and agency biologists (figure III-9); however, this range is considered noncritical due to the paucity of baseline observations. Mule deer population changes would not be noticeable. Nor would the removal of lightly used spring and fall range cause population impacts.

Traffic on the mine-access road would not alter deer range or habitat use. Mule deer have already adjusted their use patterns to existing traffic levels. Increases in traffic would not affect deer. Carbaugh et al. (1975) found that habitat use by white-tailed deer, generally more sensitive to human activity than mule deer, was not tied to variation in traffic volume.

After reclamation, the disturbance area would be used by mule deer. The additional acreage of bitterbrush (figure IV-3) would provide more foraging areas. The increased amount of foraging habitat and the unreclaimable open pit would reduce postmining forests. To compensate for this decrease in cover, deer would have to travel to offsite forests more often.

Other Big Game: Mining would not physically disturb moose habitat. Activity associated with the open pit may prevent moose from using small amounts of habitat along Clancy Creek. Ferguson and Keith (1982) showed that moose initially shift their distribution away from human activity.

Black bears would lose a considerable amount of habitat to mining (see figure III-10). They would be forced into surrounding areas. Revegetation would eventually supply suitable habitat for bears.

Other Mammals: Mining would displace coyotes and other mammals from the disturbance area. The wide-ranging coyote would be able to satisfy its life requirements in offsite habitats. Two coyote dens would be destroyed by mining. Population impacts on other mammals would be unnoticeable and revegetated lands would eventually supply suitable habitat.

Mining would eliminate or displace small mammal populations. The straw mulch and grasses used during revegetation would attract small mammals and allow repopulation of the disturbance area (Stoeckeler and Slaubaugh, 1965; McCann, 1975; Hingten and Clark, 1984).

Birds. Hunting habitat for raptors would be slightly reduced while the mine operates. Although baseline searches did not locate any raptor nests, removing 315 acres of existing forest would undoubtedly destroy some tree nests. Bald eagles rarely use the Montana Tunnels study area. This federally listed endangered species would not be affected by mining. Power lines would be designed with features to prevent raptor electrocution.

Songbirds would leave the disturbance area until revegetation creates sufficient cover. Reestablished forests would not supply adequate habitat for decades. Mining would destroy grouse habitat but would not significantly reduce grouse populations.

Indirect Impacts

Road Kills: Traffic increases on the mine-access road (see Chapter IV--Transportation) would create more opportunities for wildlife to be struck by vehicles. Although all wildlife species would stand a greater chance of being killed by vehicles, mule deer would be the most affected species. However, the increase in deer road kills would not change deer populations. The access road does not pass through any deer concentration areas or identified road crossings. Most vehicles would travel the road during the day when collisions with deer are less likely. Increased road kills by traffic along I-15 would be insignificant. Substantial increases in traffic have not been projected for this highway (see Chapter IV--Transportation).

Housing Construction: Wildlife populations would not be significantly affected by mine-related housing construction. Only 7 to 24 acres throughout Jefferson and Lewis and Clark counties would be developed as a result of the project. Much of this development may be in or near existing communities (see Chapter IV--Land Use).

Recreation: As more people become familiar with the Montana Tunnels area, the hunting of antlered deer and elk would increase. Due to the small population growth associated with the mine (see Chapter IV--Sociology), this increase would not be large enough to reduce deer or elk populations. Small game populations would not be limited by increased hunting. The Department of Fish, Wildlife and Parks would continue to limit the harvest of antlerless deer and elk; it could impose more conservative hunting regulations if necessary.

Recreation may also increase due to more people in the area. Although some wildlife harassment may occur, wildlife populations would not be significantly affected.

Poaching. Some people that become familiar with the Montana Tunnels area may occasionally poach a deer or an elk. The increase in poaching would not be noticeable.

Impacts Unique to the Proposal (Alternative 1)

The potential for elk and mule deer to be poisoned if they ingest tailings or drink from the process water pond is of concern. The factors that would determine the probability of poisoning, however, are unknown. (These factors include metal toxicities, attractiveness of salts in the tailings, quantities of materials consumed, and frequency of consumption.) The potential for poisoning would be reduced by the initial avoidance behavior of elk and deer. However, some habituated animals would eventually encounter the impoundment area. Deer, with their greater tolerance of human activity, would face a higher probability of poisoning than elk. After mining, reclamation of the tailings impoundment and process water pond would eliminate the concern about poisoning.

The blasting used during mine development would exacerbate the displacement of wildlife. Blasting would increase the anticipated withdrawal distances of deer and elk.

Some mine employees would use the Montana Tunnels area when they are not working. There may be incidences of wildlife harassment or poaching. This increase would be added to an existing poaching problem. Black bears could eventually habituate to mining activity and search for food in the permit area. If the handling of garbage is careless, bears would use garbage as a food source. The chances for bear/human encounters would increase. Traffic increases on the mine-access road (see Chapter IV--Transportation) would increase road kills of mule deer noticeably. However, this increase would not significantly affect deer populations.

The potential failure of reestablished grassland growing on the tailings impoundment (see Chapter IV--Soils and Vegetation) could lower postmining habitat quality. Wildlife would lose 195 acres of foraging habitat (figure IV-3). Conifer density in the postmining environment would be lower than premining density (see Chapter IV--Vegetation). This would reduce cover for big game species and habitat for forest birds. The lowered number of shrubs may also decrease production of deer forage. Small mammals and birds that use shrubs for cover would not find the security that existed before mining.

Impacts Unique to Alternative 2

Capping the surface of the tailings with at least 12 inches of innocuous waste before soil redistribution would help to insure that the grassland habitat reestablished over the tailings would not fail. Postmining grassland would, therefore, total 420 acres (figure IV-3). Improved forest restoration would make certain that the cover quality supplied by conifers would be similar to the quality found before mining. Reestablished shrub fields would have overall cover values below premining levels; however, the applicant would insure that shrub density would meet the habitat requirements of mule deer.

If necessary, elk and mule deer would be prevented from using the tailings impoundment and process water pond. Blasting would not significantly increase displacement of wildlife. Company policies and educational efforts would keep poaching and wildlife harassment to a minimum. Although road kills would continue to occur, reducing traffic through Jefferson City so that total trips to and from the mine are no more than one-third of the work force would keep them at an unnoticeable level. All other wildlife impacts common to alternatives 1, 2, and 3 would continue to occur.

Impacts Unique to Alternative 3

Relocating the facilities site would insignificantly change the acreages of wildlife habitat types disturbed. All other impacts would be similar to those covered under Impacts Unique to Alternative 2.

Cumulative Impacts Common to Alternatives 1, 2, and 3

The U.S. Forest Service has one existing and five proposed timber sales in the wildlife cumulative analysis area (table IV-8). Each cutting unit within the sale areas would be under 40 acres. Most of the roads constructed to harvest the timber would be closed after logging is completed. Forest managers anticipate that natural invasion by surrounding vegetation would revegetate logged sites. Tree seedlings would be planted where necessary. The Forest Service has committed to following management recommendations set forth in the Coordinating Elk and Timber Management Handbook (Montana Cooperative Elk-Logging Study Committee, 1985). Furthermore, a desired level of habitat quality would be specified and maintained (J. Jimeno, C. Frounfelker, and R. Roginske, U.S. Forest Service, pers. comm., October 1985).

No major projects are proposed for land administered by the Bureau of Land Management (BLM) within the cumulative analysis area (G. Leppart, BLM, pers. comm., October 30, 1985). Current uses of this land (grazing, small timber sales, small mining projects) would probably continue.

It is not possible to accurately predict future activities on private lands in the cumulative analysis area. However, Douglas Schmitz of the Jefferson County Commission noted that neither the county commission nor the county planning board has received any development proposals (pers. comm., November 1, 1985).

Logging, proposed for the Helena and Deer Lodge National Forests (table IV-8), would combine with mining-related development to create cumulative impacts to elk and mule deer, the most important game species.

Six logging sites would occupy the year-round range of elk that use the Montana Tunnels proposed permit area (figure IV-4). One of these areas--the Boulder Chief--also lies within mule deer range. Proposed activities that may affect wildlife were not identified for private land or land administered by BLM.

The specific impacts of logging were not predicted due to the imprecise locations available for the timber sales. Also, the locations of the cutting units have yet to be determined. Negative impacts, in general, could include habitat loss, displacement of animals, and behavioral changes (see Chapter

Table IV-8: Proposed U.S. Forest Service Timber Sales in the Wildlife Cumulative Impacts Analysis Area

Sale name	National forest	Legal location	Estimated acreage in analysis area[1]	Logging period	Miles of new road
Strawberry	Helena	Sections 5, 6, 7, 18, 19, T8N, R4W; Sections 1, 2, 12, 13, 23, 24, T8N, R5W	481	1985-1988	7.6
Lava Mountain	Helena	Sections 14, 15, 21-27, 34-36, T8N, R5W	268	1992-1996	2.5
Boulder Chief	Deer Lodge	Sections 15, 22, 23, 26, 27 T7N, R5W	409	1987-1990	5.0
Red Iron	Deer Lodge	Sections 4, 5, 6, R6N, R6W	47	1989-1992	2.0
South Fork Basin Creek	Deer Lodge	Sections 21, 27, 28, T7N, R6W	47	1991-1994	3.0
E. Jack Creek	Deer Lodge	Sections 11, 12, 13, 14, T7N, R6W	161	1993-1996	3.0

Sources: Proposed Forest Plan, Helena National Forest; Proposed Forest Plan, Deer Lodge National Forest; J. Jimeno and R. Roginski, U.S. Forest Service, pers. comm., October 31, 1985.

[1] Acres in analysis area (x)

estimated by: $\frac{\text{No. of sections in entire sale}}{\text{No. of acres in entire sale}} = \frac{\text{No. of sections in analysis area}}{x}$

IV--Wildlife). Because logging would employ a small work force over a large area, indirect impacts (road kills, increased recreation, increased poaching) would be insignificant. The negative effects of logging could be offset by federal management actions. For example, the Forest Service's plan to close most logging roads and to follow the recommendations of the Montana Cooperative Elk-Logging Study Committee (1985) would greatly reduce impacts to elk and deer.

Impacts Unique to Alternative 4

Under alternative 4, none of the effects on wildlife discussed for alternatives 1, 2, or 3 would occur.

CLIMATE

Mining of the Montana Tunnels project would not affect the climate of the area. The amount of emissions would be too small to affect precipitation or radiation balance.

AIR QUALITY

Impacts Unique to Alternative 1

The most significant impact to air quality would result from the generation of fugitive dust from the actual mining activities, particularly ore and waste removal, hauling, and dumping. Other particulate emissions sources include milling activities at the plant site (crushing, screening, and conveying), access road dust, and wind erosion of disturbed or exposed areas.

Increased levels of particulate matter resulting from the increased traffic along the road from Jefferson City to the minesite would be significant. Although the total emissions from the access road are small in relation to the mining activities (see table IV-9), the impact would be more noticeable because of the proximity of the road to Corbin and Jefferson City. The applicant has committed to applying chemical stabilization to the road surface, which would provide about 85 percent control of these emissions.

Table IV-9 lists the particulate emission sources, control practices to be used, and emission estimates for each source. Total particulate emissions on an uncontrolled basis are estimated at 1,086.5 tons per year. The actual emissions (after the application of controls) are estimated at 326.5 tons per year.

Computer modeling to determine the total suspended particulate (TSP) concentrations resulting from these emissions was performed and submitted as part of the Montana Tunnels Air Quality Permit Application (December, 1984). The maximum annual average TSP concentration outside the permit area was predicted to be 27 $\mu g/m^3$ located 2 kilometers east-northeast of the mine area. This represents an increase of 8 $\mu g/m^3$ added to the background level of 19 $\mu g/m^3$.

The maximum 24-hour TSP concentration predicted was 126 $\mu g/m^3$ located 1.2 kilometers northwest of the mine area. This represents an increase of 65 $\mu g/m^3$ added to the background concentration of 61 $\mu g/m^3$.

These predicted concentrations are well below state and federal ambient air quality standards for TSP (see table III-11). Based on the anticipated level of particulate emission control, the air quality impact would be minimal. A particulate air-monitoring network would be operated by the applicant to verify compliance with the standards and the effectiveness of the control measures used. Monitoring sites would be chosen in conjunction with MDHES. State and federal quality assurance requirements must be followed to provide accurate and representative data.

Construction activities would also produce particulate emissions; the construction phase of the project would take about 15 months. Specific

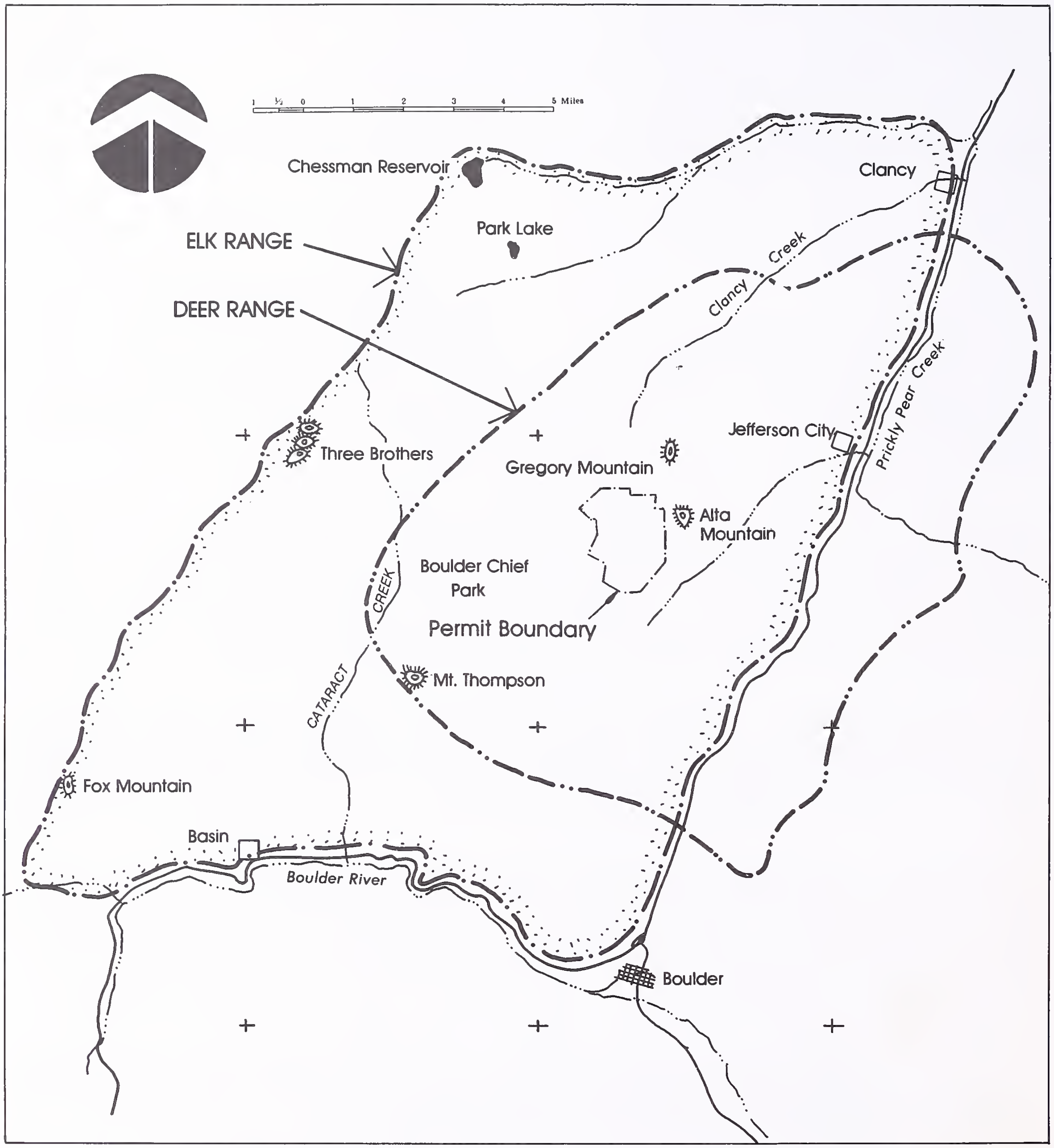


Figure IV-4
The cumulative impacts analysis area for wildlife was based on year-round mule deer and elk ranges. Agency biologists were interviewed to determine the area that could be visited by animals that also use the permit area.

Table IV-9: Particulate Emission Inventory

Activity	Uncontrolled emissions ton/yr	Operation hr/yr	Controls BACT[1]	Percent	Controlled ton/yr	Emissions lb/hr
Topsoil removal	20.3	2,450	Minimize fall distance	0	20.3	16.7
Topsoil loading/dumping	1.2	2,450	Minimize fall distance	0	1.2	1.0
Topsoil stockpiles	7.4	4,560	Revegetation	75	1.9	0.8
Disturbed areas (wind erosion)	105.3	4,560	Revegetation	75	26.3	11.6
Drilling	20.6	6,000	Dust collector	90	2.1	0.7
Blasting	1.5	30	Minimize area and overshoot	0	1.5	100.0
Ore/waste removal	205.7	7,000	Minimize fall distance	0	205.7	58.8
Ore/waste dumping	20.6	7,000	Minimize fall distance	0	20.6	5.9
Coarse ore stockpile	0.2	4,560	Watering	50	0.1	0.1
Haul roads--waste	129.2	3,644	Chemical stabilization	85	19.4	10.6
Haul roads--ore	10.2	2,550	Chemical stabilization	85	1.5	1.2
Access roads	19.6	4,560	Chemical stabilization	85	2.9	1.3
Road grading	14.6	911	Watering	50	7.3	16.0
Vehicle exhaust	3.7	7,000	Operation	0	3.7	1.1
Primary crushing	262.5	5,760	Scrubber	98	5.3	1.8
Screen, convey, and handle	262.5	8,640	Scrubber	98	5.3	1.2
Refining	1.4	2,800	Operation	0	1.4	1.0
	1,086.5				326.5	229.8

Source: Montana Tunnels project application for an Air Quality Permit, 1984.

[1] Best available control technology.

activities include handling and removing topsoil, excavation, and preproduction mine development. Emissions from these activities are estimated at about 500 tons per year. With the required precautions, such as watering of roads and work areas, the air quality impacts during construction would be similar to those during the operational phase as described above.

Trace element concentrations in the ambient air would increase slightly because of the trace elements found in the ore, waste, and tailings (see table II-6). A related concern is the portion of the access road that would be relocated south of Corbin. This area has some old tailings deposits that contain high trace element levels. In order to avoid suspended dust caused by vehicle traffic, the tailings in the immediate roadway area would be removed or buried.

Lead is the only trace element included in the ambient air quality standards (see table III-11). For comparison with the lead standard, the average lead concentration of the ore was applied to all particulate emissions with respect to the computer modeling results. This is a very conservative approach because emissions from other sources such as topsoil and waste handling and haul-road traffic have much lower lead concentrations than found in the ore. Based on the particulate modeling results, the maximum lead impact for the 24-hour period and annual average would be 0.2 and 0.02 $\mu g/m^3$, respectively. Added to the measured background levels of less than 0.03 $\mu g/m^3$, the resulting lead concentrations would be significantly less than the standard. Filters from the particulate monitoring network would be analyzed for lead and a number of other trace elements to determine if any problems develop.

Table IV-10 lists the major gaseous pollutant sources and emission levels. At these levels of emission, the ambient air impact is expected to be negligible.

After mining activities, air quality conditions would return to near the current levels. The only remaining particulate emission source would be wind erosion of exposed areas. Given adequate revegetation, these emissions would approximate current conditions. Reclamation of the tailings area would begin as soon as possible in order to minimize the amount of time tailings would be exposed to wind erosion.

Table IV-10: Gaseous Pollutant Emissions (tons/year)

Activity	Sulfur oxides	Carbon monoxide	Hydrocarbons	Nitrogen oxides
Vehicle exhaust	6.6	19.4	7.9	110.0
Explosives	9.4	314.9	N/A	79.9
TOTAL	16.0	334.3	7.9	189.9

Source: Montana Tunnels project application for an Air Quality Permit, 1984.

Impacts Unique to Alternatives 2 and 3

Implementation of a traffic reduction plan (bussing or carpooling) would reduce particulate impacts along the access road in an amount proportional to the traffic reductions achieved. Other air quality impacts discussed under alternative 1 would be the same under alternatives 2 and 3.

Impacts Unique to Alternative 4

Current air quality conditions would remain unchanged under this alternative.

EMPLOYMENT

Project Employment, Schedule, and Hiring Assumptions

(Note: Table IV-11 shows anticipated project employment over the 12-year life of mine. Construction is expected to begin March 1, 1986 and to last five quarters. During that time, employment would range from 216 to a peak of 567 employees over the first three quarters. Operations employment for the first three years would be 232 workers. During the fourth year, stripping ratios change so the work force would expand an additional 108 employees [340 total]. In the tenth year of operations, employment would fall to 116 workers during the first quarter of reclamation and demolition activity, and would continue to decline to three employees in the fifth and final quarter of phase down.

The applicant has stated that it intends to hire all but 17 operations employees locally [Mountain International, Inc., 1985, p. 51]. The local work force would be drawn from Jefferson, Lewis and Clark, and Silver Bow counties. The applicant has prepared a hard-rock mine impact mitigation plan as required by state law. That plan, written to address impacts in Jefferson County, assumes that 80 percent of both the operation and construction work force can be hired locally except during the fourth quarter of peak construction activity when only 70 percent of the work force is estimated to be local. Of the local work force, 50 percent is expected to live in Silver Bow County and commute to the minesite over the life of the project. The remainder is split, assuming that Jefferson County residents comprise 12.5 percent of the work force, and Lewis and Clark County residents make up 37.5 percent of the work force [Mountain International, Inc., 1985].

Employment forecasts prepared by DSL estimate a range [low and high scenarios] of employment for Jefferson and

Table IV-11: Project Employment Schedule

Activity	Number of Employees 2 qtr 1986	3 qtr 1986	4 qtr 1986	1 qtr 1987	2 qtr 1987	3 qtr 1987 to 2 qtr 1990	3 qtr 1990 to 2 qtr 1997	3 qtr 1997	4 qtr 1997	1 qtr 1998	2 qtr 1998	3 qtr 1998
Construction (contract)	200	210	368	551	208							
Operations	16	16	16	16	16	232	340	96	42	16	5	3
Reclamation								20	20	20	12	
Demolition (contract)									25	25	15	
TOTAL	216	226	384	567	224	232	340	116	87	61	32	3

Source: Kilborn Engineers and Centennial Minerals Ltd., *in* Mountain International, Inc., 1984, p. 50.

Lewis and Clark counties. The low scenario incorporates the assumptions the applicant used in the Jefferson County hard-rock mining impact plan [see table IV-12]. The high scenario anticipates that more of the project workers would reside or locate in Lewis and Clark County than estimated by the applicant. If Butte workers hired by Montana Tunnels were to relocate to Helena, or if other mine projects such as the Chartam or Washington projects were to compete for the local labor force, such employee location assumptions could more accurately estimate employment effects of the project. The Chartam project, a proposed open-pit gold mine near Winston, Montana, may begin construction in mid-1988, depending on results of additional exploration activity [Chuck Rose, Environmental and Special Projects Coordinator, pers. comm., October 8, 1985]. The Washington Corporation, which purchased the Anaconda property in Silver Bow County, is reviewing the possibility of re-opening the Berkeley Pit. A decision will likely be made around mid-December, 1985 [John Theibus, Washington Corporation, October 2, 1985].

The applicant has estimated that it can hire as many employees as it needs from the local area based on the number and skills of job service applicants in Lewis and Clark and Silver Bow counties, the number of Butte mine

Table IV-12: Employment Allocation by County

	1986		1987		1988		1990		1995		1997		1998		2000	
County	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Jefferson	42	55	47	63	35	47	51	68	51	68	33	44	3	5	0	0
Lewis and Clark	124	165	141	188	105	139	153	204	153	204	101	133	11	14	0	0
Silver Bow	109	55	126	63	92	46	136	68	136	68	87	44	10	5	0	0
Total average annual employment	275	275	314	314	232	232	340	340	340	340	221	221	24	24	0	0

Assumptions: Average annual employment was calculated using quarterly and annual totals shown in table IV-11.

Low employment allocations were based on the worker location assumptions of the Montana Tunnels Project Hard-Rock Mine Impact Mitigation Plan for Jefferson County, Montana. These are: 80 percent of the work force is hired locally with 50 percent coming from Silver Bow, 12.5 percent from Jefferson County, and 37.5 percent from Lewis and Clark County. Twenty percent of the work force is made up of nonlocal employees--one-fourth of whom live in Jefferson County and three-fourths of whom live in Lewis and Clark.

High employment allocations assumed that 60 percent of the work force resides in Lewis and Clark County with the remainder split evenly between Jefferson and Silver Bow counties. There are no assumptions about local versus nonlocal hire in the high employment allocations.

> workers laid off when the Anaconda Copper Company closed the Berkeley Pit, and the number [858] of job applications received by the applicant [Mountain International, Inc., 1985, pp. 57-65]. However, the applicant also assumes that there will be no other area-mining project constructed or operating that would compete for the skilled labor force [Mountain International, Inc., 1985, p. 57]).

Impacts Common to Alternatives 1, 2, and 3

Jefferson County

Employment effects of the project would vary depending on the number of project workers residing in Jefferson County (see table IV-11 for project employee location allocations). The higher the number of employees residing in the county, the greater the increase in basic and nonbasic employment.

Table IV-12 shows estimated employment in Jefferson County for selected years due to the Montana Tunnels project. Over the life of the project, employment would range from 0.7 percent to 3.6 percent greater than the baseline forecasts. Employment impacts shown in table IV-13 are common to alternatives 1, 2, and 3.

The employment multiplier used in the forecast is the same as in the baseline projections--one basic job to 0.3 nonbasic. The creation of nonbasic jobs is lagged one year after the change in basic employment, which may be too short.

The employment impacts are highest during the final seven years of project production. Over that time period, the project may provide from 51 to 68 basic mine jobs and from 15 to 20 induced nonbasic jobs to the Jefferson economy (65 to 88 total). At peak employment, such gains represent an increase of between 2.9 to 3.6 percent above levels forecast without the project in 1995 (see table IV-13).

Lewis and Clark County

Lewis and Clark County employment would experience a greater increase in the number of jobs than would the Jefferson County economy. However, the percentage change in total county employment due to the project would be smaller. Employment impacts are the same for alternatives 1, 2, and 3.

Table IV-14 compares the employment forecasts for Lewis and Clark County with and without the project. Over the life of the project, total employment could increase up to 1.5 percent above the estimated level without the project. Growth in nonbasic employment would result from increased spending by mine employees from both Jefferson and Lewis and Clark counties.

As in Jefferson County, impacts are highest during the peak of operations. In 1995, employment is predicted to increase between 306 to 408 jobs, depending on the number of project workers choosing to reside in Lewis and

Table IV-13: Jefferson County Employment With the Project

	1986		1987		1988		1990		1995		1997		1998		2000	
Employment	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Baseline basic[1]	1,323	1,325	1,322	1,333	1,318	1,342	1,311	1,357	1,312	1,433	1,313	1,415	1,319	1,431	1,318	1,444
Additional basic	42	55	47	63	35	47	51	68	51	68	33	44	3	5	0	0
Total basic with project	1,365	1,380	1,369	1,396	1,353	1,389	1,362	1,425	1,363	1,501	1,346	1,459	1,322	1,436	1,318	1,444
Baseline nonbasic[1]	897	898	906	913	913	930	930	962	982	1,017	1,009	1,089	1,016	1,101	1,044	1,145
Additional nonbasic	0	0	0	0	5	7	11	14	15	20	15	20	9	13	0	0
Total nonbasic with project	897	898	906	913	918	937	941	976	997	1,037	1,024	1,109	1,025	1,114	1,044	1,145
Total baseline employment	2,220	2,223	2,228	2,246	2,231	2,272	2,241	2,319	2,294	2,450	2,322	2,504	2,335	2,532	2,362	2,589
Total employment with project	2,262	2,278	2,275	2,309	2,271	2,326	2,303	2,401	2,360	2,538	2,370	2,568	2,347	2,550	2,362	2,589
Percent increase	1.9	2.5	2.1	2.8	1.8	2.4	2.8	3.5	2.9	3.6	2.1	2.6	0.5	0.7	0.0	0.0

[1] Mountain International, Inc., 1984, p. 115.

Assumptions: Construction employment does not foster creating nonbasic jobs because it is short term. The employment multiplier is 1 basic to .3 nonbasic, and nonbasic job creation/reduction is lagged one year from the change in basic employment.

Table IV-14: Lewis and Clark County Employment With the Project

Employment	1986		1987		1988		1990		1995		1997		1998		2000	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Baseline basic	10,616	10,793	10,728	10,920	10,841	11,048	11,206	11,310	11,811	11,971	12,061	12,237	12,189	12,373	12,447	12,647
Project basic	124	165	141	188	105	139	153	204	153	204	101	133	11	14	0	0
Total basic employment with project	10,740	10,958	10,869	11,108	10,946	11,187	11,359	11,514	11,964	12,175	12,162	12,370	12,200	12,387	12,447	12,647
Baseline nonbasic	13,292	13,514	13,432	13,673	13,574	13,834	13,989	14,118	14,741	14,940	15,054	15,272	15,212	15,442	15,536	15,785
Project-induced nonbasic	0	0	0	0	53	70	105	139	153	204	153	204	101	133	0	0
Total nonbasic with project	13,292	13,514	13,432	13,673	13,627	13,904	14,094	14,257	14,894	15,144	15,207	15,476	15,313	15,575	15,536	15,785
Total baseline employment	23,908	24,307	24,160	24,593	24,415	24,882	25,195	25,428	26,552	26,911	27,115	27,509	27,401	27,815	27,983	28,432
Total employment with project	24,032	24,472	24,301	24,781	24,573	25,091	25,453	25,771	26,858	27,319	27,369	27,846	27,513	27,962	27,983	28,432
Percent increase	0.5	0.7	0.6	0.8	0.6	0.8	1.0	1.3	1.2	1.5	0.9	1.2	1.0	1.0	0.0	0.0

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[1] The high employment baseline forecast was drawn from Mountain International, Inc., 1984, p. 120.

Assumptions: Construction employment is too short term and erratic to foster creation of nonbasic jobs. The employment multiplier is one basic job to one nonbasic job, and nonbasic job creation/reduction is lagged one year from the change in basic employment.

Clark County. Such increases represent a rise of 1.2 to 1.5 above the level without the project.

Effects of Closure to Both Counties

The project is expected to end operations the third quarter of 1998. Employment would fall from 340 to 116 in 1997 when reclamation and demolition begins at the project site. Employment would continue to decline until reclamation is complete.

After the project ceases operations, total employment in Jefferson and Lewis and Clark counties would fall to a level that it would have been without the project (see table IV-13 and table IV-14). The adjustment period may take several years longer than suggested in table IV-13 and table IV-14, and may create hardships for unemployed mine workers and secondary (nonbasic) businesses dependent on the added income from the project. Service and retail trade establishments may lay off employees as county income and spending decline; some businesses may be forced to close also.

Unemployed project workers may find other jobs; some may retire. Some may leave the area to find employment elsewhere.

A temporary closure can have the same employment impacts as a permanent closure if it lasts long enough. Short-term closures create economic hardships for project employees and businesses that depend on their trade. Usually, however, total employment is not affected as drastically as when a mine closes permanently.

Impacts Unique to Alternative 4

Jefferson County

If the permit were denied, the applicant would not construct the project. Employment would remain unchanged from the baseline forecasts.

Lewis and Clark County

If the permit were denied, the project would not be developed. Employment would remain unchanged from the baseline forecast.

Cumulative Impacts Common to Alternatives 1, 2, and 3

Employment in Lewis and Clark and Jefferson counties would increase if the proposed Chartam project near Winston, Montana were developed. It would provide another 100 to 150 basic jobs to the area, including Broadwater County. Employment impacts would depend on where the employees locate. The mine would be about 17 miles from East Helena, 22 miles from Helena and Montana City, and 13 miles from Townsend. If the work force were to locate equally between the three counties, Lewis and Clark would garner an additional

33 to 50 basic jobs and 33 to 50 nonbasic jobs (66 to 100 total) while Jefferson would receive 33 to 50 basic jobs and 10 to 20 nonbasic jobs (43 to 70 total). Total employment increases would not be noticed until at least one year after the project was in full production, probably in 1990 or 1991. Such increases would account for less than 0.1 percent above estimated baseline levels in Lewis and Clark County and close to 2 percent above projections for Jefferson County. Actual employment gains in Lewis and Clark County would probably be higher, however, because more workers may settle in the Helena area due to its cultural, educational, and economic amenities.

INCOME

Impacts Common to Alternatives 1, 2, and 3

Jefferson County

The impact of the Montana Tunnels project on personal income in Jefferson County could vary radically depending on the number of county residents hired and the number of project employees who move to the county. Table IV-15 presents estimates of increases in county income due to project employment. The low-range estimate is based on hiring and worker location assumptions resembling those proposed in the applicant's hard-rock impact mitigation plan (see Chapter IV--Employment and Population). The high range scenario assumes that fewer workers are hired from Silver Bow County, and that the number hired or locating in the study area increases. According to the hiring assumptions used by the applicant in the hard-rock impact mitigation plan, Butte-Silver Bow residents would receive 40 percent of the project jobs, yet proportionally

Table IV-15: Impact of Montana Tunnels Project on Jefferson County Personal Income

	1986		1988		1990		1995	
Income	Low	High	Low	High	Low	High	Low	High
Baseline income (thousands of 1980 dollars)	$63,425		$65,987		$68,653		$75,798	
Project income (thousands of 1980 dollars)	887	1,159	913	1,370	1,174	1,728	1,614	2,169
Percentage of increase	1.4	1.8	1.4	2.1	1.7	2.5	2.1	2.9

Assumptions: Income estimates were based on average annual mine employment from quarterly totals estimated by the applicant. The annual mining wage paid to miners, mine and mill management, and technical employees was assumed to be $24,470--the average mining industry wage in Jefferson County in 1983. Construction wages were assumed to be $22,694 yearly, a weighted average of construction industry earnings for Lewis and Clark and Jefferson counties for 1982 and 1983. Clerical, security, and janitorial staff were assumed to earn $12,036 annually, the average wage in 1983 in Lewis and Clark County (U.S. Department of Commerce, 1984). Project employment by type and skill was drawn from the hard-rock mine impact mitigation plan.

their share of project income would be greater, because such workers would probably fill jobs that require a greater skill level and pay higher than jobs requiring less mining experience.

Proportionally, Jefferson County personal income would increase more than that of Lewis and Clark County. Estimated increases would range from 1.4 to 2.9 percent over the life of the project. The largest impacts occur during the final seven years of production, between the third quarter of 1990 and the second quarter of 1997. Project income would provide 2.1 to 2.9 percent boost to total county income during that time period.

Income impacts during construction could range from 1.4 to 1.8 percent above the baseline forecast. Actual increases in total personal income could be higher, however. The wages of temporary, migrating workers assumed to locate in the county were not included in the impact analysis. Such workers save a large percentage of their income, spending less than 30 to 40 percent in the locale of their temporary residence. The potential income to service and retail trade businesses from temporary worker residents could generate gains in those sectors in 1986 and 1987, however, such gains are difficult to predict and are likely to be erratic.

Spending by project operations employees would also induce secondary or nonbasic job creation. The retail trade and services sectors would be the main beneficiaries. Table IV-16 shows estimated income due to growth in nonbasic employment. Construction employment is too short term to induce creation of any nonbasic jobs or income. The year that mine-induced, nonbasic employment and income are predicted to grow would be the first year (1988) following the start of mine production. For every three mine jobs added to

Table IV-16: Mine-Induced Nonbasic Income for Jefferson County (thousands of 1980 dollars)

	1990		1995		2000
Income	Low	High	Low	High	
Baseline total personal income	$68,653		$75,798		$83,687
Project-induced nonbasic income	83.6	106.4	114.0	151.9	-0-
Percentage of increase	0.1	0.2	0.2	0.2	-0-
Total mine-related income	1,257	1,835	1,728	2,321	-0-
Percentage of increase	1.2	2.7	2.3	3.0	-0-

Assumptions: Average annual mine employment and income were used to estimate nonbasic income due to the project. Changes in nonbasic income were lagged one year from the change in mine-operations employment. Nonbasic income was generated by multiplying the estimated number of new, mine-induced nonbasic jobs by the 1983 weighted average of wages in the services and retail trade sector of Jefferson County (U.S. Department of Commerce, 1984).

the county, one additional nonbasic job should be created. The wage rate for each nonbasic job is estimated to be the weighted average of retail trade and service-sector employee earnings in 1983. The high and low ranges are based on the same worker location assumptions as those in table IV-15.

At peak employment, nonbasic income is expected to range between $114,000 to $152,000 annually. Such amounts represent about 0.2 percent increase above baseline forecasts for total personal income.

When the mine payroll and nonbasic income are added together, the project-induced earnings are estimated to add $1.7 to $2.3 million to total personal income in 1995. Such increases could raise county personal income 2 to 3 percent above the baseline forecast in 1995.

Lewis and Clark County

The Montana Tunnels project would affect personal income in Lewis and Clark County. Project-related earnings would total more in Lewis and Clark County than in Jefferson County; however, the overall impact would be a much smaller proportion of total county income.

Table IV-17 shows estimated income in Lewis and Clark County due to the project. At peak employment, mine income would add between 0.5 and 0.7 to total personal income in 1995. Earlier increases cause a smaller percentage rise in county income.

Table IV-17: Impact of Montana Tunnels Project on Lewis and Clark County Personal Income

	1986		1988		1990		1995		2000
Income	Low	High	Low	High	Low	High	Low	High	
Baseline forecast (thousands of 1980 dollars)	$523,138		$544,272		$580,277		$565,530		$742,803
Project income (thousands of 1980 dollars)	1,692	2,319	1,826	2,764	2,348	3,457	3,228	4,338	-0-
Percentage of increase	0.3	0.4	0.3	0.5	0.4	0.6	0.5	0.7	-0-

Assumptions: Income estimates were based on average annual mine employment from quarterly totals derived by the applicant. The annual mining wage paid to miners, mine and mill management, and technical employees was assumed to be $24,470--the average mining industry wage in Jefferson County in 1983. Construction wages were assumed to be $22,694 yearly, a weighted average of construction industry earnings for Lewis and Clark and Jefferson counties for 1982 and 1983. Clerical, security, and janitorial staff were assumed to earn $12,036 annually, the average wage in 1983 in Lewis and Clark County (U.S. Department of Commerce, 1984). Project employment by type and skill was drawn from the hard-rock impact plan.

The estimates of basic mine earnings developed for Lewis and Clark County are based on the same assumptions as those used in the Jefferson County forecast. The low-range scenario is most representative of the hiring and worker location assumptions used by the applicant. The high-range scenario would be indicative of a situation where more employees lived in or were hired from the Helena and East Helena area. The high-range scenario could occur if the Washington Corporation were to reopen the Berkeley Pit, the Western Energy Company were to proceed with the proposed Chartam project in mid-1988, or if more of the unemployed Anaconda workers were to leave Butte to get jobs elsewhere.

Secondary income due to the Montana Tunnels project would be more significant in Lewis and Clark County than in Jefferson. The Helena area is a regional trade center and draws shoppers from northern Jefferson County. As such, nonbasic employment is expected to increase one job for each mining employee who locates in Helena (see Chapter IV--Employment). Wage rates in the sectors most likely to receive nonbasic employment increases (retail trade and services) are higher in the Helena area than in Jefferson County (U.S. Department of Commerce, April, 1984).

Table IV-18 shows estimated income due to secondary employment growth in Lewis and Clark County. Percentage increases, although small, are almost double those for Jefferson County. In 1995, when the project is at peak employment, secondary earnings gains would represent a 0.3 percent increase above total personal income. Basic and nonbasic project income combined could add between 0.7 to 1.0 percent to total county income in 1995.

Table IV-18: Project-Induced Nonbasic Income Increases in Lewis and Clark County (thousands of 1980 dollars)

	1990		1995		2000
Income	Low	High	Low	High	
Total personal income	$580,277		$656,530		$742,803
Project-induced nonbasic income	1,146.5	1,517.7	1,670.6	2,227.5	-0-
Percentage of increase	0.2	0.3	0.3	0.3	-0-
Total mine-related income	3,949	4,975	4,899	6,565	-0-
Percentage of increase	0.7	0.9	0.7	1.0	-0-

Assumptions: Average annual project employment and income were used to estimate nonbasic income due to the project. Changes in nonbasic employment and income were lagged one year from the change in project-operations employment. Nonbasic income was derived by multiplying nonbasic employment times the weighted average earnings in the retail trade and services sectors in Lewis and Clark County in 1983 (U.S. Department of Commerce, April, 1984).

Effects of a Temporary or Permanent Closure in Both Counties

The applicant plans to close the Montana Tunnels project in 1998. Mining and milling operations would cease in the second quarter of 1997 and employment levels would decline throughout the demolition and reclamation of the project. Within several years after project closure, income levels in both counties would decline to the level estimated without the project.

If laid off workers were able to find other jobs in the study area, income impacts would be less severe. Many miners may accept jobs that do not fully use their skills in order to stay in the area. Workers unable to find other employment may receive unemployment compensation. Eventually, some discouraged and underemployed workers may leave the area to get other jobs.

Loss of the mine payroll may force some service and retail trade businesses to decrease employment and service levels. If consumer spending declines are significant enough, some businesses that grew or expanded due to the project may close.

Loss of employment and income creates stress and hardship. The additional cost and income loss to communities due to social problems resulting from such stress is almost impossible to measure. Yet, it can be significant, particularly if unemployment occurs during a period of general economic downturn.

The effects of a temporary mine closure resemble those of a permanent closure. Usually, however, the magnitude of income loss is less during a temporary closure. If operations are closed long enough, temporary cessations can be as severe as those during the first few years of a permanent closure.

Cumulative Impacts

If the Chartam project begins construction in 1988, the proposed mine could cause increases in personal income in both counties. The mine would employ between 100 to 150 people. East Helena and Townsend are almost equidistant from the proposed site. If employment were split evenly between Lewis and Clark, Jefferson, and Broadwater counties, basic earnings in Lewis and Clark County could rise between $808,000 to $1.2 million annually while nonbasic income could increase $360,000 to $546,000 annually. Such amounts would be about 0.1 to 0.2 percent above estimated baseline income. Added to the income generated by the Montana Tunnels project, employment at both mines would contribute an additional 1.2 percent to total Lewis and Clark County income in 1995. Jefferson County could receive between 33 to 50 basic mine jobs and between 10 to 15 nonbasic jobs. Such employment gains could add between $808,000 to $1.2 million to annual basic earnings, and $76,000 to $114,000 to annual nonbasic income. In 1995, cumulative income increases could add 3.4 to 4.6 percent of total county earnings, an increase of 1.5 percent above the estimated level due solely to the Montana Tunnels project.

Development of another hard-rock mine near the study area would increase the dependence of both counties on potentially cyclical industries. If the permanent or temporary closures of both projects were to occur within 2 to 5 years of each other, income reductions and resulting impacts would be amplified.

Impacts Unique to Alternative 4

If the Montana Tunnels project were not developed, real personal income would continue to increase about 2 percent annually. Earnings in both counties would continue to be dominated by government income and growth in nonlabor income. Jefferson County would continue to have an important mining sector. However, earnings from that industry would be less significant to total county income without the Montana Tunnels payroll. The potentially cyclical income and employment patterns of hard-rock mining would be less evident in both counties.

SOCIOLOGY

Impacts Common to Alternatives 1, 2, and 3

Demography

There are many possible scenarios of where the mine and mill workers would come from and where they would reside. Although most of the scenarios assume that a portion of the work force would come from Butte and from Silver Bow County, there are factors that may affect the number of people moving to the study area. (These factors are discussed in Chapter IV--Employment.) Because it is not possible to accurately predict the origin of the work force and settlement patterns, two scenarios (high and low) for employment and net migration were developed. These scenarios allow for analysis of a range of possible impacts that may occur if the applicant is not able to hire 80 percent of the workers locally.

Employment scenarios are presented in table IV-19 and IV-20 that represent low- and high-impact situations. The low-impact scenario assumes that 20 percent of the project operations' work force would reside in Jefferson County, 40 percent in Lewis and Clark County, and 40 percent in Silver Bow County. During the construction phase for both the scenarios, 60 percent of the construction workers would come from Lewis and Clark County, 20 percent from Silver Bow County, and 20 percent would come from Jefferson County. This scenario is considered low-impact because of a relatively high proportion of the available work force that would come from Butte.

The expected nonbasic employment numbers in table IV-19 were generated using a basic-to-nonbasic employment ratio of 0.3 in Jefferson County and 1.0 in Lewis and Clark County. The nonbasic figures lag one year from changes in basic employment.

Table IV-20 presents a high-impact scenario where 20 percent of the Montana Tunnels work force would live in Butte, 20 percent in Jefferson County, and 60 percent in Lewis and Clark County. Nonbasic employment was computed and construction employment was distributed as in table IV-19. This scenario is presented as a high-impact estimate because of the number of employees that

Table IV-19: Montana Tunnels Employment Projection, Low-Impact Scenario, 1986-2000

	Construction				Operations			
	1986	1987	1988	1989	1990-96	1997	1998	2000
Total employment								
Basic mine employment	275	314	232	232	340	221	24	0
Jefferson County								
Basic employment	55	62	46	46	68	45	4	0
Nonbasic employment	0	17	19	14	14	20	13	0
Total employment	55	79	65	60	82	65	17	0
Lewis and Clark County								
Basic employment	165	126	93	93	136	88	10	0
Nonbasic employment	0	165	126	93	93	136	88	0
Total employment	165	291	219	186	229	224	98	0
Silver Bow County								
Basic employment	55	126	93	93	136	88	10	0
Nonbasic employment	0	55	126	93	93	136	88	0
Total employment	55	181	219	186	229	224	98	0
Total employment due to mine								
Basic employment	275	314	232	232	340	221	24	0
Nonbasic employment	0	237	271	200	200	292	189	0
Total employment	275	551	503	432	540	513	213	0

would reside in Lewis and Clark County instead of Silver Bow County. This projected high impact could occur if fewer workers were hired from Silver Bow County.

Two scenarios (low and high) are also presented for expected in-migration to the study area due to the proposed project (table IV-21). No migration is expected into Silver Bow County under either of the scenarios because of the availability of an unemployed work force in Butte.

The difference in the two scenarios is the work force distribution as presented in table IV-19 and IV-20 and assumptions concerning migration rates. These migration rates are the same for Jefferson County under both scenarios. About 84 people (28 families) are projected to move into Jefferson County in the first 3 years with 39 more people moving in by 1990, when the mine becomes fully operational.

In Lewis and Clark County, different migration rates were assumed for the high- and low-impact scenarios. For the high-impact scenario, it was assumed that 30 percent of the construction work force and 50 percent of the operations work force would move from outside the study area. For the low-impact scenario, it was assumed that 10 percent of the construction workers and 40

Table IV-20: Montana Tunnels Employment Projection, High-Impact Scenario 1986-2000

	Construction				Operations			
	1986	1987	1988	1989	1990-96	1997	1998	2000
Total employment								
Basic mine employment	275	314	232	232	340	221	24	0
Jefferson County								
Basic employment	55	62	46	46	68	45	4	0
Nonbasic employment	0	17	19	14	14	20	13	0
Total employment	55	79	65	60	82	65	17	0
Lewis and Clark County								
Basic employment	165	188	140	140	204	132	15	0
Nonbasic employment	0	165	188	139	139	204	133	0
Total employment	165	353	328	279	343	336	148	0
Silver Bow County								
Basic employment	55	64	46	46	68	44	5	0
Nonbasic employment	0	55	63	46	46	68	44	0
Total employment	55	119	109	92	114	112	49	0
Total employment due to mine								
Basic employment	275	314	232	232	340	221	24	0
Nonbasic employment	0	237	270	199	199	292	190	0
Total employment	275	551	502	431	539	513	214	0

Table IV-21: Expected Net Migration, 1986-2000, Low and High Scenarios

	Construction				Operations			
	1986	1987	1988	1989	1990-96	1997	1998	2000
Jefferson County								
Basic employment migration	17	5	0	0	13	0	0	0
Nonbasic migration	0	5	1	0	0	2	0	0
Total employment migration	17	10	1	0	13	2	0	0
Number of people	51	30	3	0	39	6	0	0
Lewis and Clark County								
Basic employment migration	17-50	0-12	0	0	17-32	0	0	0
Nonbasic migration	0	17	2	0	0	4-6	0	0
Total employment migration	17-50	17-29	2	0	17-32	4-6	0	0
Number of people	51-150	51-87	6	0	51-96	12-18	0	0

percent of the operational workers would move to the area. For both scenarios, it was assumed that 10 percent of the new nonbasic employees would migrate into Lewis and Clark County and that the average family size would be three people per family--the state norm in 1980.

Based on the previous assumptions, between 36 and 81 families would migrate into Lewis and Clark County during the first 3 years of mine construction and development. As the mine becomes fully operational (1990), about 17 to 32 more families would move to Lewis and Clark County, for a total of 43 to 113 new households over the life of mine. The new families in Jefferson County would probably reside in the Clancy-Montana City area. The families in Lewis and Clark County are expected to reside in the Helena Census Division, which includes Helena, East Helena area, and the Helena valley.

Social Values

The nature and magnitude of perceived impacts on social values would vary among individuals. Some residents, particularly in the Boulder area, would view the project positively because it would increase employment, economic investment, the tax base, and overall economic security. Individuals hired to work on the project, their families, and local businesses would benefit directly from increased income and commerce. Other residents, however, may consider the project a social liability because it would attract newcomers, increase traffic and noise near the project area, change the environmental setting of the area, and generally increase the pace of life. Such impacts would reduce the quality of life for some individuals and decrease some individuals' sense of security, integration, and cohesion with the community. Residents in Jefferson City and the Wickes-Corbin area would most likely be affected by changes brought about by construction and operation of the project. Traffic to and from the mine would increase, local land use would change, and the rural atmosphere of the area may become more urbanized.

Social Structure and Interaction

The impact of the proposed project on social structure and interaction would depend on the size of the in-migrating population, their life styles, demographic characteristics, and settlement patterns. If newcomers are similar in age, education, and marital status to the existing population and have similar expectations of their community, integration into the existing social structure would be enhanced. If newcomers' housing is well distributed among existing residences, adverse social impacts also would be reduced.

Some local residents share similar values, life styles, and personal expectations with miners and laborers because of the mining history of the Boulder area. These residents probably would not perceive newcomers to be threatening or alien. Other residents, however, such as state employees at the BRSH and ranching families, may not closely resemble newcomers demographically, socially, or philosophically. Therefore, acceptance of miners and their families by these residents may be slower. Slow integration could cause the newcomers to form separate social groups and compete for power and status in the community.

With the hiring of local residents and an influx of newcomers, the socioeconomic orientation of the communities of Boulder-Basin would shift from a dependence on work such as logging, construction, and the BRSH to more of an affiliation with mining. This association probably would be reflected in local political choices which could favor mining interests.

Social Institutions--Economic Life

Employment of a large portion of the work force from Jefferson County would be a boost to the local population and would increase local financial investments. The degree of economic dependence on the BRSH would be reduced to some extent.

Social Problems

Depending on the number of newcomers and selection of residence location, existing social problems could be exacerbated. For example, if newcomers settle in the northern end of Jefferson County, the ability to provide public services would be additionally strained. Also, crime would probably increase, thereby imposing an added burden on the Jefferson County sheriff department. Even without the project, there is concern that the sheriff's department is understaffed.

Mine Closure

Temporary or early plant closure would increase economic insecurity in the Boulder-Basin area and could cause economic hardship for employees and their families. Local businesses that expanded to meet the increased demand for goods and services generated by the project could face economic hardship.

Social and economic impacts in the area following permanent mine closure would depend on factors such as the rate at which the mine would curtail operations, alternative employment options for displaced miners, the level and rate of people leaving the area, and the degree to which the mine-related population had become integrated into the community.

Community Services

Impacts on community services would occur because of increased migration into the area by workers and their families. Predicting the precise nature and magnitude of the impacts would depend on the number of newcomers and their settlement patterns. If they settled in the northern end of Jefferson County or other rural areas, increased demands would be placed on some community services which currently are being stressed.

Education

The proposed project would affect schools in Jefferson County by increasing enrollment. Student enrollment would increase by about 12 students in grades K through 8 and 6 students at the high school level during construction. In 1990, enrollment is expected to increase by 7 students for grades K through 8 and 3 students in high school.

In the Lewis and Clark study area, 16 to 36 in-migrant students would enroll in grades K through 8, and 8 to 18 students would enroll in high school during mine construction. During operation, 9 to 16 more mine-related students would enroll in grades K through 8 and enrollment in the high schools would increase by 5 to 8 students.

In the Helena schools, most of the elementary, middle, and high schools have sufficient classroom space to accommodate the small numbers of new students that may attend as a result of construction and operation of the mine. New teachers, however, may be required if students are not distributed evenly throughout the schools or grades.

East Helena schools are approaching capacity; however, construction of a new school allowing for about 300 more students should be complete in 1986. If school enrollment continues to increase at the present rate, capacity could be reached in 7 to 9 years.

Law Enforcement

The Jefferson County Sheriff Department would experience impacts from the proposed project because of increased demands for law enforcement. Increased traffic, vehicle accidents, and crime would create additional work for the existing deputies. The influx of mine workers and their families would increase the feelings of anxiety of some residents concerning inadequate law enforcement in the county.

The applicant has proposed to provide Jefferson County with $18,000 to upgrade the sheriff department's communication system. The applicant also has agreed to commit the mine security staff as special duty deputies to be used on an as-needed basis by the sheriff's department (Jeff Baker, consultant to Jefferson County, pers. comm., 1985).

Additional law enforcement problems in the study area could result if the project attracts transients migrating to the area seeking employment. New developments such as the proposed mine often attract unemployed people who may commit crimes. Both Lewis and Clark and Jefferson county sheriff departments are understaffed and increased mine-related criminal activity would aggravate the workload of the deputies.

Increased commuter traffic on Interstate 15 would require additional law enforcement activities by the Montana Highway Patrol. Mine-related traffic also would increase on the Corbin-Wickes Road and more accidents would occur.

Fire Protection

The Helena and Boulder fire departments are adequately staffed and equipped to provide fire protection for newcomers to these communities. Rural areas, however, are served by volunteer fire departments, which are not adequately equipped to fight major fires. Newcomers moving into rural areas would increase the demands on these volunteer departments. Because the mine/mill complex would not be located in any rural fire district, the area does not have fire protection. The applicant, however, has committed to providing fire protection of the mine and associated facilities, making donations to local fire departments, and providing training associated with special chemicals or mine accidents.

Ambulance

The Boulder Ambulance Service would experience additional emergency calls resulting from traffic-related accidents on Interstate 15 and the Corbin-Wickes Road, and possibly from accidents at the project facilities complex. The applicant has agreed to maintain an ambulance and first aid station staffed by EMTs at the mine. In addition, the applicant would make donations to the Boulder Ambulance Service and Clancy Quick Response Unit to assist with additional operating costs that may be incurred by mine-related emergency services. Therefore, no significant impacts are expected on existing emergency medical services in either Jefferson or Lewis and Clark counties.

Hospitals

St. Peter's Hospital would experience a slight increase in the number of admissions primarily because of traffic- and project-related accidents. The hospital has adequate staff and facilities to meet this demand in health services.

Physicians

Physicians in Jefferson and Lewis and Clark counties would have a slight increase in patient care due to the in-migrating workers. Increased health care needs would be in the form of routine and emergency cases of illness or injury, traffic-related accidents, and industrial accidents. There is a sufficient number of physicians to accommodate this increase in medical services.

Water Supply

Increased water demand associated with the mining complex and new residences would have no adverse impact on municipal water supplies. Helena and Boulder have sufficient municipal water to ensure adequate supplies for expanded domestic and industrial use. East Helena currently experiences water shortages during some summers, but has applied for a Community Block Grant to construct additional wells to meet present and future demands.

Rural water supplies come from private wells. There is adequate ground water to supply wells in most future residential locations in the study area.

Wastewater Treatment

Wastewater treatment facilities in Boulder, Helena, and East Helena are not operating at design-flow capacity; therefore, new residents from mining-related activities would not adversely affect these facilities. New residents who would settle in rural areas would have to install septic tank systems for wastewater disposal. Potential impacts due to construction and operation of septic tank systems would have to be evaluated on a site-specific basis.

Solid Waste

There would be no significant impact on solid waste pickup and disposal except possibly in northern Jefferson County. The boxes in northern Jefferson County are at capacity and it is unknown at this time whether the placement of two new boxes has corrected this situation.

There are two potential impacts of concern associated with refuse in northern Jefferson County--the increase in population of project workers creating more refuse, and the increase of an incoming construction force using the landfill, but not paying the annual landfill charge. The applicant would pay $570 through the contingency fund to help offset any additional expenses incurred due to this "free-loader" problem. However, because there is no way of predicting the number of workers who would settle in northern Jefferson County, it is uncertain whether additional boxes would be needed.

Other portions of the Jefferson County study area can accommodate additional mine-related increases in refuse. Lewis and Clark County would experience no adverse impact related to solid waste collection and disposal.

Utilities

There would be no impact on utilities as a result of the project.

Social Welfare

Transient job seekers moving to the study area hoping to secure work at the mine/mill complex may increase the number of welfare recipients. Because there are not sufficient personnel to adequately administer welfare programs in the study area, additional demands would stress the existing programs.

Commercial Services

Commercial services in the study area would benefit from the mine through increased retail sales and increased demands for services.

Housing

Newcomers would have adequate housing options if they were willing to commute from the Helena area to the mine site. Housing in the Boulder area is, however, more limited, and housing in northern Jefferson County is more expensive than in other portions of the study area. If newcomers chose to settle in Jefferson County, they would be faced with a limited choice of permanent housing in the Boulder area, should expect to pay relatively high prices for housing in northern Jefferson County, or would need to construct new housing units to better suit their personal circumstances. Another housing option that would allow settlement closer to the mine site would be locating mobile homes on vacant parcels of land.

Cumulative Impacts Common to Alternatives 1, 2, and 3

Western Energy Company is considering the development of a hard-rock mine (Chartam) near Winston, Montana, that would employ 100 to 150 workers. If the applicant hired 80 percent of the work force locally, it is estimated that a total of 30 employees would move to Lewis and Clark and Broadwater counties. By dividing the work force evenly between both counties, 15 families (or about 45 people) would be expected to reside in the Helena and East Helena areas. Unless all families resided in the same service-area jurisdiction (for example, school district) the impacts of this population increase on the existing social environment would be minimal.

Impacts Unique to Alternative 4

The project would not be developed if the permit were denied. The small influx of workers due to exploration activities would not have any adverse effect on the existing social environment. Therefore, no change would occur in the study area if the project were not developed.

FISCAL

Impacts Common to Alternatives 1, 2, and 3

The project would generate direct and indirect increases in government revenues. Jefferson County, Jefferson high school district #1, and the Clancy elementary school district #1 would receive direct property tax receipts from the project. Indirect tax revenue would be generated by in-migrating project employees who build homes, license vehicles, and purchase other licenses and services, and by local workers who buy additional taxable goods and services due to project wages. Jurisdictions throughout the study area may receive indirect tax increases.

Direct Fiscal Impacts

Table IV-22 shows estimates of the taxable value of the project. A high and low case is presented for the mine and mill complex and for the value of gross proceeds. The estimates do not include project construction equipment or land. The mine and mill would be assessed and taxed according to the classification of the type of property (for example, class V property with a taxable percent of 3.0 percent includes pollution-control equipment, class X

Table IV-22: Components of Project Taxable Value (thousands of 1984 dollars)[1]

Fiscal	Mine/mill taxable value		Gross proceeds taxable value		Total
year	High case[2]	Low case[3]	High case[4]	Low case[5]	low case
1988	$5,920.7[6]	$5,920.7[6]	$ 0	$ 0	$5,920.7
1989	5,595.1	5,476.7	2,762.4	2,357.5	7,834.2
1990	4,881.6	4,659.6	2,762.4	2,357.5	7,017.1
1991	5,549.4	3,919.5	2,762.4	2,357.5	6,277.0
1992	4,887.1	3,291.9	2,304.8	2,009.5	5,301.4
1993	4,025.0	2,622.9	2,304.8	2,009.5	4,632.4
1994	3,133.1	1,906.5	2,304.9	2,009.5	3,916.0
1995	2,312.8	1,255.2	2,304.8	2,009.5	3,264.7
1996	1,516.1	1,255.2	2,304.8	2,009.5	3,264.7
1997	1,516.1	1,255.2	2,304.8	2,009.5	3,264.7
1998	1,516.1	1,255.2	2,304.8	2,009.5	3,264.7
1999	0	0	2,304.8	2,009.5	2,009.5

Source: Centennial Minerals Ltd., Kilborn Engineering Ltd., Montana Code Annotated, Metals Week in Mountain International, Inc., 1985, p. 76.

[1] Taxable value does not include project construction equipment or land.

[2] Includes capital additions and depreciation.

[3] Includes depreciation and no capital additions.

[4] Gold = $350/oz.; Silver = $7.50/oz.; Zinc = $0.49515/lb.; Lead = $0.30509/lb.

[5] Gold = $300/oz.; Silver = $6.00/oz.; Zinc $0.44/lb.; Lead = $0.22/lb.

[6] Does not assume new industrial property classification for the mine. If implemented, the new industrial classification would reduce 1988 total taxable value to $1,679,113 plus the taxable value of land. The taxable value would remain at or below that value until 1991.

property with a taxable percent of 16.0 includes ore trucks). The gross proceeds of a metal mine are considered class II property, and taxable value equals three percent of total annual market value.

Jefferson County

The taxable value of Jefferson County would increase initially by 38 percent of the (FY85) nominal level, and could rise between 51 and 54 percent following the first full year of production. The percentage of change in taxable value would vary annually, depending on the price of gold and scheduled depreciation of property. If the current lawsuits protesting taxation of the Bonneville Power transmission line are upheld, the project could offset declines in taxable value.

Jefferson County tax receipts from the project would depend on the county levy in effect. The FY85 levy would generate an additional $379,000 (nominal dollars) in FY89, and up to $534,000 in FY90. Such amounts would add 15 to 20 percent respectively to current budget levels. Project property tax revenue would be adequate to cover costs of providing government services necessitated by the project.

Jefferson County High School District #1

The applicant has agreed to pay each affected school district in Jefferson County an amount equal to the state school foundation payment for each in-migrating mine student who enrolls in the district before such time as the applicant has made its first property tax payment after the start of commercial operations. Any such payments made to the Jefferson high school district #1 would be considered tax prepayments.

The taxable value of Jefferson high school district #1 would increase due to the project. During the first year of operation, the project would add 57 percent to the nominal FY85 taxable value. In the second year, increases would range from 76 to 81 percent above the current level. Such increases would offset declines in taxable value if the BPA transmission line is removed from the tax base.

Jefferson high school district #1 would receive revenues adequate to cover increased educational costs due to the project. The district may be able to lower or stabilize levies depending on the marginal tax receipts from Montana Tunnels.

Clancy Elementary School District #1

The Clancy elementary school district would receive payments from the applicant for mine-related students who enroll during the time before the first property tax payment made by the company after the start of commercial operations. Such payments would be considered prepayments for which the applicant may receive a credit against future tax liabilities.

The taxable value of the Montana Tunnels property and production would add about 168 percent to the FY85 taxable value of property within the district. In the second year of production when the gross proceeds are assessed, taxable value could increase from 254 to 278 percent above the current nominal level. Direct project tax revenues would be adequate to cover increased costs of educational services in the Clancy elementary district.

State Revenues

The state imposes two taxes on hard-rock mines. Both are based on the gross value of mineral production. The metal mines license tax is levied at graduated rates with $250,000 to $500,000 of the gross value taxed at 0.5 percent; $500,000 to $1.0 million taxed at 1.0 percent; and in excess of $1.0 million is taxed at 1.5 percent. The Resource Indemnity Trust Tax is imposed at a rate of 0.5 percent on the gross value of mineral production in excess of $25,000, or $25.00 for mines producing less than $25,000 gross annual output.

Table IV-23 shows the estimated amount of each tax that the Montana Tunnels project would pay at selected metal prices. At current metal prices (average for the week ended October 4, 1985), the state would receive about $1.2 million annually. Higher metal prices (gold at $350/ounce) would yield yearly tax revenue of $1.4 million and lower prices (gold at $300/ounce) would yield $1.2 million. The current price for lead and zinc is below the low-scenario estimate, while gold and silver are wholesaling at higher prices than estimated in the low-range estimate.

Indirect Tax Revenues

Indirect increases in tax revenues would be generated due to project employee consumption spending. The largest indirect increases would come from purchases and property of in-migrating project workers and sales of newly constructed homes to any project employee. Indirect increases in such revenues can occur throughout the study area, depending on location of project employees.

There is enough excess service capacity and potential marginal tax revenue to offset increased costs of providing government services and facilities to new mine-related households in the study area in most jurisdictions. However, if unusual conditions were to arise, some local governments could be affected.

Table IV-23: Estimated State Revenues at Selected Metals Prices (nominal dollars)

Ore	Price	Gross value of annual production (millions)	Metal Mines License Tax	Resource Indemnity Trust Tax	Total
Gold	$350/oz	$65,800,000	$654,250	$328,975	$983,225
Silver	$7.50/oz	20,725,000	103,500	53,500	157,000
Zinc	$0.49515/lb	14,158,000	137,830	70,665	208,495
Lead	$0.30509/lb	1,278,000	9,030	6,265	15,295
Total high prices		$91,961,000	$904,610	$459,405	$1,364,015
Gold	$325.62/oz	$61,216,560	$608,416	$305,958	$914,374
Silver	$6.32/oz	9,037,600	86,626	45,063	131,689
Zinc	$0.365596/lb	10,453,487	100,785	52,142	152,927
Lead	$0.19153/lb	802,319	5,785	3,887	9,672
Total current 10/85 prices		$81,509,966	$801,612	$407,050	$1,208,662
Gold	$300/oz	$56,400,000	$560,520	$281,875	$842,395
Silver	$6.00/oz	8,580,000	82,050	42,775	124,825
Zinc	$0.44/lb	12,580,920	122,059	62,780	184,839
Lead	$0.22/lb	921,580	10,466	4,483	14,948
Total low prices		$78,482,500	$775,095	$391,913	$1,167,008

Source: Mountain International, Inc., 1985, p. 75 and Metals Week, October 4, 1985 pp. 4-5. Annual production is estimated to be 188,000 ounces of gold; 1,430,000 ounces of silver; 28,593,000 pounds of lead; and 4,189,000 pounds of zinc.

If students who move to the area as a result of the project are not distributed evenly throughout grades, or if most such students are enrolled in the same elementary school district, two school districts would be affected. Montana City elementary district #1 and the East Helena elementary district #9 are most susceptible to negative fiscal impacts.

Cumulative Impacts

The fiscal impact of the proposed Chartam project on the study area would be small. The area would receive indirect tax revenues from in-migrating Chartam workers and from additional license and service fee income. Increases in indirect tax revenues would depend on the settlement and purchasing patterns of employees.

Impacts Unique to Alternative 4

If the project were not developed, Jefferson County, Jefferson high school district #1, the Clancy elementary school district #1, and the state would not receive estimated project tax revenues. All area jurisdictions would forgo potential indirect tax revenues generated from mine employees' consumption spending. Local area governments would not experience increased costs due to the project.

Current fiscal trends in the study area would continue. Real taxable value is expected to increase slowly as the area economy recuperates from the effects of the recession.

LAND USE

Impacts Common to Alternatives 1, 2, and 3

Direct Land Use Impacts

The 1,549-acre permit area would be closed to all activities unrelated to mining for the life of the operation. As a result, between 282 and 401 animal unit months (AUMs) of grazing would be lost temporarily. The smaller number represents the recommended stocking rate for current range conditions the larger number represents the potential stocking rate for excellent range conditions.

The postmining landscape would contain significantly reduced acreages of grassland and forest. This decrease would correspond with a proposed increase in shrub/grassland and the creation of an open pit (see Chapter IV--Vegetation and Wildlife).

Conflicts between mining land uses and recreational land uses in the Montana Tunnels area would probably be minimal. Mining traffic on the road between Jefferson City and the minesite may create minor inconveniences for hunters and other recreationists. Mining may also cause elk and deer to avoid some previously used habitats until they become accustomed to the increased noise and activity (see Chapter IV--Wildlife).

Indirect Land Use Impacts

Indirect land use impacts would occur due to people moving into Jefferson and Lewis and Clark counties to take mining jobs, and subsequently building new homes. Conversion of agricultural land to residential uses would depend on the number of nonlocal employees hired by the applicant and the housing preferences of those employees.

About 7 acres of agricultural land in Jefferson County and between 10 and 17 acres of agricultural land in Lewis and Clark County could be converted to residential uses under a worst-case scenario. Such figures assume that each residence uses 0.25 acre, that there are 26 nonlocal employees who settle in Jefferson County and between 40 and 69 nonlocal employees who settle in Lewis and Clark County, and that each nonlocal employee builds a new home (see Chapter IV--Sociology). Land use conversions of this magnitude would be insignificant to agricultural production in Jefferson and Lewis and Clark counties.

Impacts Unique to the Proposal (Alternative 1)

As proposed, the mine and associated facilities would disturb a total of 965 acres--887 acres of native vegetation, 45 acres of cropland, and 33 acres of previously disturbed land. The applicant's reclamation plan would successfully return native vegetation to about 608 acres of the total disturbance area. The 162-acre pit would remain essentially barren of vegetation (see Chapter IV--Vegetation), and would eventually fill with water (see Chapter IV--Hydrology). Initially, grassland vegetation would be established successfully on the surface of the tailings impoundment. However, due to possible soil acidification and contamination from the underlying tailings, plant mortality would increase with time (see Chapter IV--Soils). In a worst-case scenario, most or all of the vegetation on about 195 acres of the surface of the tailings impoundment could fail after many decades.

As a result of the pit and the long-term tailings impoundment revegetation problems, about 357 acres of land would not be returned to its original use. This amounts to about 37 percent of the total disturbance area. Because of this, about 40-60 animal unit months (AUMs) of grazing would be permanently lost. All other agricultural uses would also be precluded in this 357-acre area.

Impacts Unique to Alternative 2

Under alternative 2, the mine and associated facilities would disturb a total of 965 acres--887 acres of native vegetation, 45 acres of cropland, and 33 acres of previously disturbed land. Because soil acidification and contamination would not occur under this alternative, about 803 acres would be successfully returned to native vegetation. The 162-acre pit would remain essentially barren of vegetation, just as it would under the applicant's proposal (alternative 1). Therefore, the pit area--about 17 percent of the total disturbance area--would not be returned to its original land use. Because of this, about 20-30 animal unit months (AUMs) of grazing would be permanently lost. All other agricultural uses would also be precluded in the 162-acre pit area.

Impacts Unique to Alternative 3

There are no impacts unique to alternative 3. Land use impacts for this alternative are the same as those discussed for alternative 2.

Impacts Unique to Alternative 4

Under alternative 4, none of the land use impacts discussed for alternatives 1, 2, or 3 would occur.

TRANSPORTATION

Impacts Common to Alternatives 1, 2, and 3

The largest rise in traffic would occur during the third quarter of construction. At that time, the applicant would employ 567 people and trucks would be travelling to the site with supplies and materials. When the project is operational, the project work force would total 232 for the first three years and 340 during the final seven years of production. An undetermined number of supply trucks would haul materials to the mine and ore trucks (dump truck size) would haul ore concentrate to East Helena. Although exact numbers of vehicles would differ under alternatives 2 and 3, traffic patterns would remain the same.

Impacts Unique to the Proposal (Alternative 1)

Although the applicant has stated its intent to investigate the possibility of establishing a bus or shuttle service, such a service would be provided only if it is cost-effective and can operate efficiently (Mountain International, Inc., 1985, p. 128). Because the applicant has not given a firm commitment or submitted an actual plan to reduce mine-related traffic, this analysis assumes that the permit application contains no such mitigation.

Project traffic impacts would be greatest and would be significant on the Corbin-Wickes Road (see table IV-24). Mine traffic is estimated to cause a 300- to 450-percent increase above the level of traffic measured in 1983. Such increases would result in a much greater likelihood of accidents, significantly higher levels of noise and dust, and substantially more inconvenience to and traffic congestion for local residents and recreationists. Project traffic would also increase significantly in the residential areas of Jefferson City, resulting in a much greater potential for accidents, higher levels of noise, and inconvenience to area residents. Property values along the major thoroughfares may fall due to such large traffic volumes, although the amount of such decreases cannot be predicted.

Traffic increases along I-15 (see figure III-12, a map that shows roads in the project area) are expected to be small to moderate for most locations (see table IV-25). However, mine traffic at the Jefferson City interchange would cause much larger increases because all employee and truck traffic would enter and exit at that location. Such growth is estimated to range from 12 to

Table IV-24: Mine-Induced Traffic Increases Along the Corbin-Wickes Road and Through Jefferson City

Year	Jefferson City estimated mine traffic		Percentage of increase above 1983 traffic level on Corbin-Wickes Road[1]	
	Low	High	Low	High
1986	250	252	387.4	389.7
1987	255	288	393.1	431.0
1990	278	312	419.5	458.6
1995	278	312	419.5	458.6
1997	179	203	305.7	333.3

[1] Robert Peccia and Associates estimated an average daily traffic count of 87 vehicles on the Corbin-Wickes Road.

Assumptions: Two traffic estimates were made. The low estimate assumes that workers commute to the minesite from the location (by school district) anticipated in the applicant-authorized Montana Tunnels Project Hard-Rock Mine Impact Mitigation Plan for Jefferson County, Montana (p. 80). The high scenario assumes commuting patterns based on worker allocations made in the high population and employment impact scenario in Chapter IV. Additionally, in the high-traffic forecast, it was assumed that all Jefferson County employees lived at the respective location being analyzed. Household trips were estimated to be four trips per day per in-migrant in the study area. Households were located in the same manner as employees for both scenarios, and each employee was assumed to represent one household. The number of in-migrant households was taken from the low- and high-range population forecast scenarios in Chapter IV.

17 percent over the life of the mine. The most noticeable increase would occur during the third quarter of construction activity. However, estimates were prepared using average annual employment, so some quarters of construction activity would cause a smaller increase than 12 percent, while others would cause greater than 17 percent increase along I-15.

Estimating project-related traffic impacts is greatly influenced by the assumptions of where project workers will live and the number of riders per commuting vehicle. Table IV-24 shows an estimated range of traffic increases corresponding to the worker location employee settlement patterns in the Chapter IV demography and employment sections. The low-range forecast is based on assumptions which resemble those used by the applicant in the impact analysis in the Montana Tunnels Project Hard-Rock Mine Impact Mitigation Plan for Jefferson County, Montana.

Project-related traffic impacts on FAP 69 could be serious if all the workers estimated to locate in or be hired from Jefferson County were to live in the Whitehall-Cardwell area. In that extreme-condition analysis, traffic increases are estimated to be 11 to 16 percent near the FAP 69-FAS 359

Table IV-25: Estimated Project-Induced ADT Increases Along Portions of I-15[1]

	1986		1987		1990		1995		2000
Location	Low	High	Low	High	Low	High	Low	High	
Montana City interchange									
Without project estimate	4,834		4,904		5,119		5,499		5,907
With project estimate	5,104	5,154	5,087	5,194	5,362	5,475	5,744	5,862	5,907
Percentage of increase	5.6	6.6	3.3	5.9	4.7	7.0	4.5	6.6	0
Clancy interchange									
Without project estimate	3,297		3,379		3,635		3,992		4,200
With project estimate	3,563	3,618	3,562	3,669	3,878	3,991	4,237	4,355	4,200
Percentage of increase	8.1	9.7	5.4	8.6	6.7	9.8	6.1	9.1	0
Jefferson City interchange									
Without project estimate	2,201		2,239		2,358		2,570		2,802
With project estimate	2,535	2,550	2,522	2,561	2,708	2,749	2,926	2,968	2,802
Percentage of change	15.1	15.9	12.6	14.4	14.8	16.6	13.9	15.5	0
Boulder interchange									
Without project estimate	2,140		2,171		2,266		2,433		2,612
With project estimate	2,204	2,296	2,271	2,288	2,373	2,427	2,540	2,598	2,612
Percentage of change	3.0	7.3	4.6	5.4	4.7	7.1	4.4	6.8	0
Jefferson/Silver Bow county line									
Without project estimate	1,514		1,536		1,605		1,727		1,859
With project estimate	1,542	1,542	1,600	1,568	1,674	1,640	1,796	1,762	1,859
Percentage of change	1.8	1.8	4.2	2.1	4.3	2.2	4.0	2.0	0

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[1] Two traffic estimates were made. The low estimate assumes that workers commute to the minesite from the location (by school district) anticipated in the applicant-authorized Montana Tunnels Project Hard-Rock Mine Impact Mitigation Plan for Jefferson County, Montana (p. 80). The high scenario assumes commuting patterns based on worker allocations made in the high population and employment impact scenario in Chapter IV. Additionally, in the high-traffic forecast, it was assumed that all Jefferson County employees lived at the respective location being analyzed. Household trips were estimated to be four trips per day per in-migrant in the study area. Households were located in the same manner as employees for both scenarios, and each employee was assumed to represent one household. The number of in-migrant households was taken from the low- and high-range population forecast scenarios in Chapter IV.

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junction (see table IV-26). However, such a settlement pattern is unlikely. A more realistic possibility would be that shown by the low-range scenario which assumes that almost one-half of the Jefferson County employees locate south of the project, but also assumes that a greater number of project employees will locate in the Whitehall-Cardwell area than anticipated by the applicant. Therefore, such location assumptions should produce impact estimates that would more closely resemble possible project-employee settlement patterns.

Table IV-26: Estimated Traffic Increases Along FAP 69 Under Low-Range and Extreme-Condition Analyses[1]

Location	1986	1987	1990	1995	2000
Near junction of FAP 69 and FAS 539					
Without project estimate	768	779	813	872	904
With project estimate--low range	800	814	850	910	
Percentage of increase	4.2	4.5	4.6	4.4	
With project estimate--extreme case	892	863	939	1,002	904
Percentage of increase	16.1	10.8	15.5	14.9	0
Near Boulder city limits and I-15 junction					
Without project estimate	1,912	1,931	1,970	2,070	2,175
With project estimate--low range	1,944	1,966	2,007	2,108	
Percentage of increase	1.7	1.8	1.9	1.8	
With project estimate--extreme case	2,036	2,015	2,054	2,200	2,175
Percentage of increase	6.5	4.4	4.3	6.3	0

[1] The low-range estimate assumes that almost half of the estimated Jefferson County employees commute from the Whitehall-Cardwell area, and that 32 employees commute daily from the Whitehall area with an average of 2.8 employees per car. The extreme condition assumes all employees estimated to live in Jefferson County (see population forecasts Chapter IV) commute from the Whitehall area with 2.8 riders per vehicle during both operational phases. Households (one per mine worker) are assumed to make four supply trips daily.

Traffic impacts near the Boulder junction at highway 69 and Interstate 15 should be low to moderate even under extreme-condition analysis. Impacts would approach a significant level only if the number of workers estimated to live in or south of Boulder along FAP 69 tripled (from 55 to 165). Such an occurrence is a remote possibility.

Impacts Common to Alternatives 2 and 3

The applicant would be required to submit a plan to reduce traffic such that, at a minimum, when measured at the Jefferson City interchange, mine-related trips (going to and leaving the mine) are no greater than one-third of the work force. Providing company incentives to establish carpools to accomplish this goal would mean that each commuter vehicle would carry on average slightly more than three persons. If the applicant were to establish a bus or shuttle service, traffic could be reduced by even greater amounts than by implementing car pools. The following impact analysis will present the traffic reductions possible if only car pools were developed; impacts could be reduced substantially more if a bus or shuttle service is established and employees used such a service.

Table IV-27 shows projected reductions in traffic on the Corbin-Wickes road with mitigating measures. Total traffic would be reduced by almost one-third.

Table IV-27: Mine Traffic Increases on the Corbin-Wickes Road with Mitigating Measures[1]

Year	Traffic increases with no mitigation	Traffic increases with mitigations	Percentage of decrease
1986	252	183	27.4
1987	288	209	27.4
1990	312	227	27.3
1995	312	227	27.3
1997	203	147	27.6

[1] The high scenario traffic estimate was used for traffic level with no mitigation.

Assumptions: In projecting traffic increases, the annual average work force was used. Quarterly amounts in 1986 and 1997 will vary due to the fluctuation in the number of persons hired during construction and reclamation.

Other area roads--I-15 and FAP 69--would benefit from such traffic reductions as well. Total projected increases would fall at all locations; however, the impacts would be reduced most at the Jefferson City interchange. Projected increases in the extreme-condition scenario would fall such that mine-caused traffic increases would be reduced to a level below those estimated in the low-range scenario.

Impacts Unique to Alternative 4

If the permit were denied, there would be no traffic impacts to area roads. Baseline traffic growth would continue at projected small annual increases ranging from 1 to 2.5 percent. Area residents would not be inconvenienced by mine-induced traffic growth. The applicant would not construct a new road to the mine site and would not upgrade the Corbin-Wickes Road (see Hard-Rock Impact Mitigation Plan, Chapter I).

RECREATION

Impacts Common to Alternatives 1, 2, and 3

The 1,549-acre permit area would remain closed to the general public for the life of the project. Hunters and other recreationists would find it necessary to go around the area. However, the inconvenience to recreationists would be insignificant because the surrounding area offers abundant and diverse recreational opportunities (see Chapter III--Recreation). After mining, the applicant may allow the general public to use the land once again.

Because the applicant plans to hire 80 percent of its work force locally, no significant increase in recreational use of the area surrounding the project is expected.

Impacts Unique to the Proposal (Alternative 1)

There are no recreational impacts unique to the proposal.

Impacts Unique to Alternative 2

Under alternative 2, more land would be reclaimed successfully than under alternative 1 because possible long-term soil acidification would be mitigated (see Chapter IV--Soils). Vegetation growth would draw wildlife to the area, enhancing enjoyment of the area for hunters, hikers, and other recreationists.

Impacts Unique to Alternative 3

There would be no recreational impacts unique to alternative 3.

Impacts Unique to Alternative 4

If the permit were denied, recreationists would probably continue to have access to the project area.

CULTURAL RESOURCES

Impacts Common to Alternatives 1, 2, and 3

The waste rock dump would eventually destroy most of the remains of the Washington Mine (24JF481); the lower portion of the Minah Mine (24J742), including the roaster ovens, flue, and stack; and the Van Sickles Homestead site (24JF744), although the owners would tear down the log cabin and shed. Also destroyed would be a rock cairn (MAL1).

The tailings dam and impoundment would destroy the Freyler homestead site (24JF746). The pit would destroy both the Montana Tunnels site (24JF749) and Sites, Dunges, Markin mine/homestead (24JF743). The large, log cabin (the Lyon house) in the unsurveyed area of the northwest portion of the project area would also be destroyed by excavation of the pit. The house could be relocated. In either case, the applicant would complete necessary survey work.

The Belle Lode Mine (27JF747), Jas Hill miner's camp (24JF748) and Northern Pacific Mine (27JF747), and four 1940 vintage cars (MAL2) would not be directly affected by the project.

The towns of Corbin and Wickes, the Alta Mine, the Gregory Mine, the Comet and Bertha mines, Corbin Flats, and other landmarks in the area would not be directly affected by the project. Increased activity and people in the area due to the mine could add to vandalism and souvenir collecting, thereby indirectly affecting the integrity of these sites.

Impacts Unique to the Proposal (Alternative 1)

The proposal would have no impacts different from alternatives 2 or 3.

Impacts Unique to Alternatives 2 and 3

These alternatives have no impacts different from the proposal.

Impacts Unique to Alternative 4

Historic sites within and adjacent to the project area would not be destroyed or adversely affected by the project. With denial, additional information and recording of the Washington Mine (24JF481) and Minah Mine (24JF742) would not occur as committed to by the applicant.

AESTHETICS AND NOISE

Impacts Common to Alternatives 1, 2, and 3

Visual Impacts

The proposed project would disturb almost 1,000 acres for the life of the project. The entire project would be visible from part of the Elkhorn Mountains to the east, as well as Mount Thompson and points along the Occidental Plateau to the southwest. The waste rock dump would be especially visible; over the life of the mine it would reach over 400 feet above the landscape. The nearby communities of Wickes and Corbin would not have views of the project because topography isolating them from the project area. Travelers along the gravel roads in the area would have occasional glimpses of the project, especially the waste rock dump and tailings impoundment. However, as mining progressed, and especially after mine closure, all but the 162-acre pit would be revegetated. The pit would starkly contrast the surrounding landscape.

Noise

Project equipment, haul trucks, and employee vehicles would cause the most noise in the project area. Equipment includes road graders, crawler tractors, electric shovels, air-track drills, and ore-processing machinery.

The community of Wickes, sheltered from the project area by the natural landscape, would experience negligible increases in noise levels. Neither community has hospitals, schools, or libraries (project application, 1984).

Corbin, on the other hand, would experience a dramatic increase in noise from traffic because of workers driving to and from the mine. In addition, concentrator trucks would make trips from the mine site to an ore-processing complex in East Helena adding to the increase in noise.

Impacts Unique to the Proposal (Alternative 1)

Because of the possibility of eventual soil acidification, vegetation on the reclaimed trailings impoundment area (about 195 acres) could fail. This failure would result in large patches of barren ground, which would be visible in the area indefinitely.

Impacts Common to Alternative 2 and 3

Traffic noise would be reduced by the mitigating measure designed to limit mine-related round trips to no more than one-third of the work force.

Impacts Unique to Alternative 4

If the project permit were denied, scars from past mining would remain. The project area would retain its rural identity.

Chapter V: Resource Commitments and Land Uses

This chapter discusses, by discipline and where applicable, any effects of the project that would cause irreversible or irretrievable commitment of area resources, that is, those aspects of resources that would be lost to the area indefinitely or permanently. A comparison of the short-term uses of this environment and the maintenance and enhancement of long-term productivity is also included.

GEOLOGY

Mining of the open-pit gold and silver mine would physically remove the ore body, but most of the gold and silver produced would be preserved due to recycling and collecting. Non-precious metals would not be recycled as much and would eventually be lost. However, abundant supplies of these non-precious metals exist both in the United States and worldwide.

HYDROLOGY

Flow in springs within a one-mile radius of the open pit could be temporarily reduced. The pit would also induce seepage from Clancy Creek. During the life of the mine, no more than 90 gallons per minute would seep into the pit from Clancy Creek.

Continuous pumping of the ground water production wells near Spring Creek could temporarily dewater a reach of this creek containing a population of small trout.

The depletion of flow in Spring Creek would diminish the flow of Prickly Pear Creek and potentially affect downstream senior appropriators during periods of low flow.

Seepage from the tailings disposal facility would occur through the base of the impoundment as well as through the process water retention pond. Seepage through the tailings impoundment would most likely end up as storage in unsaturated alluvium. Seepage through the process-water retention pond is considered significant and may cause an increase in the concentration of arsenic and total cyanide reaching Spring Creek for a period of 5 to 10 years.

Excavation of a large, open pit would affect existing ground water flows. As many as 10 springs would be physically destroyed.

Long-term seepage from Clancy Creek into the pit would be about 10 gallons per minute. This amount of flow would not be available for downstream senior appropriators.

After mining, the pit would continue filling with poor-quality water for about 480 years. Upon reaching equilibrium, the water in the pit would be about 610 feet deep with a surface area of 103 acres. About 15 gallons per minute of poor-quality water would continue to seep into the Homestake Creek ground water system.

AQUATICS

Mining would temporarily reduce abundance and diversities of aquatic organisms in Spring Creek and possibly a short reach of Prickly Pear Creek. After mining, aquatic communities would eventually achieve premining diversities, if historic mining activities do not affect upper Spring Creek.

FISHERIES

Mining would displace or destroy a population of small trout in Spring Creek. After mining, water of insufficient quality may prevent repopulation for 5 to 10 years.

VEGETATION

The open pit and the failure of vegetation on the tailings site would reduce vegetation by 357 acres. The proportions of vegetation types in the permit area would be changed by mining. Over time, the sparse ground cover and low plant diversity of reclaimed lands would increase. The heights and densities of woody species would also increase.

The 162-acre pit would remain essentially devoid of vegetation. Topsoil quality would limit the initial establishment of seeded plants. Plant diversity and shrub densities would be lower than premining conditions. Some shrub species would be eliminated. Several decades would be required for planted trees to reach premining heights. Problems that could be encountered during revegetation include occasional erosion on steep slopes, introduction of weeds, and damage to developing plants by wildlife.

WILDLIFE

While the mine operates, the removal of 932 acres of habitat and mining activity would force wildlife from the permit area and adjacent habitats. The increased numbers of animals in undisturbed habitat would increase competition for resources. Mule deer, elk, and other species may eventually habituate to mining activities and use habitats near the permit area. After the mine closes, revegetation would allow wildlife to return to the area. However, due to the open pit and possible vegetation failure on another site, wildlife habitat could be reduced by 357 acres (37 percent of the disturbance area). Furthermore, years would be required to return browse and cover plants to premining levels.

SOILS

For all disturbance areas except the tailings impoundment surface, long-term reductions in soil quality would be minimal or negligible. Over the life of the operation, about 75 percent of the soils that would be disturbed would deteriorate in quality due to prolonged storage in the stockpiles. After reclamation, soil quality would improve with time and eventually reach premining levels.

Over the long term, the soils redistributed on the surface of the tailings pond could acidify and become contaminated with trace elements. This would result in eventual destruction of most or all of the vegetation which, in turn, would result in the loss of the soils due to erosion. This long-term impact would not occur under alternatives 2, 3, or 4.

AIR QUALITY

During the life of the mining operation, air pollutant concentration would be higher than current levels. With the completion of mining and reclamation, the pollutant concentrations would return to premining levels.

SOCIOLOGY

Social conflict in the Boulder-Basin area may develop between people supporting the project and those opposing it. This conflict would result in polarization of factions within the community and slow integration of newcomers associated with the project into the community.

The proposed project would alter social and economic life within the community but the nature of the change would be perceived differently by residents.

LAND USE

Some agricultural land could be converted to residential uses. Under a worst-case scenario, 7 acres of agricultural land in Jefferson County and between 10 and 17 acres of agricultural land in Lewis and Clark County would be permanently removed from production. Under the proposal (alternative 1), about 357 acres of the disturbance area would not be returned to its original land use; therefore, about 40-60 animal unit months (AUMs) of grazing would be permanently lost, and all other agricultural uses would be precluded in this 357-acre area. Under alternatives 2 and 3, about 162 acres of the disturbance area would not be returned to its original land use; therefore, about 20-30 AUMs of grazing would be permanently lost, and all other agricultural uses would be precluded in this 162-acre area.

RECREATION

Over several decades, the land could return to grazing land and wildlife range. Hunting and other recreational activities could resume in the project area once revegetation provides adequate wildlife habitat and vegetative cover.

CULTURAL RESOURCES

Nine historic sites and two historic loci would be destroyed. However, historic information on the sites would be recorded and placed in archives for research.

Destruction of the historic sites in the project area is unavoidable, although proper recording would preserve the historical significance of the sites.

AESTHETICS

The 162-acre pit would remain a prominent, manmade feature in a natural landscape.

The proposed mine would drastically change the rural setting of the area for the duration of mining. The project would destroy some native vegetation leaving barren patches in the area. However, the applicant would revegetate the waste rock dump and tailings impoundment, and would remove all project structures after mining is completed. Except for the open pit and possibly the tailings impoundment site, the land would return to a natural state, and would eventually blend in with the surrounding landscape.

The 162-acre pit would always remain a prominent, manmade feature surrounded by natural landscape.

Chapter VI: Appendixes

APPENDIX 1

Generalized Geologic History

The project area is part of the Rocky Mountains, a long chain of mountains extending from Mexico to Canada. The geologic events leading to the formation of these mountains span nearly 2 billion years. Until 200 to 100 million years ago, western North America was gradually subsiding and accumulating thick sequences of marine sedimentary deposits; alternating sequences of sandstone, shales, limestones, etc., deposited in advancing and retreating shallow tropical seas. The sediments were then uplifted, pushed westward, intruded, and covered by molten rocks, forming the ancestral Rocky Mountains.

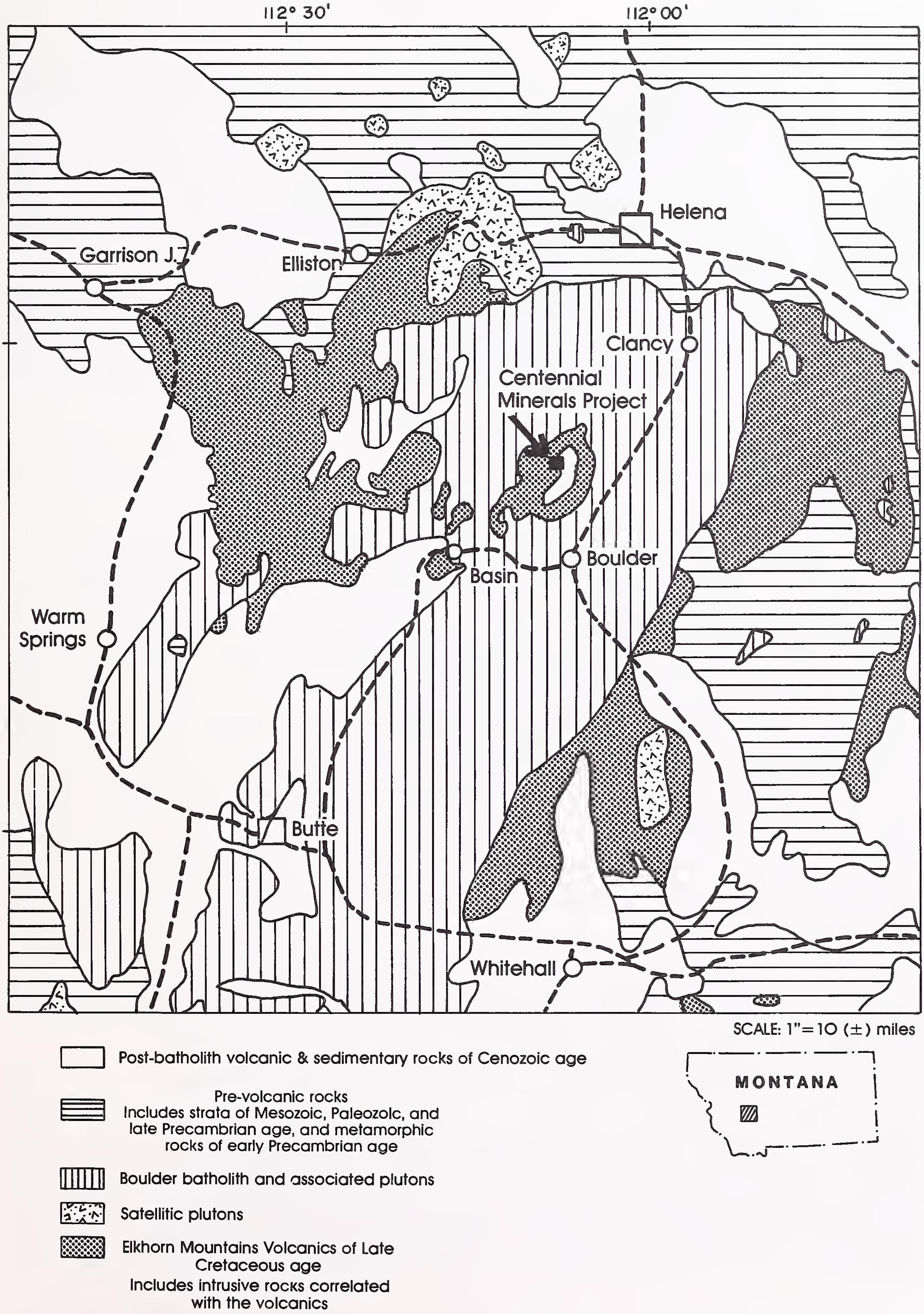
The bulk of mountain building in Montana was completed during the span of time from 100 to 50 million years ago. Then, as eastward compressive forces dropped off, the newly uplifted western North American continent broke into blocks, downdropping valleys relative to adjacent mountain ridges. This block-faulting valley-and-mountain sequence is prevalent over the entire western United States. Erosion of the mountain tops and deposition in the valleys further reshaped the mountains forming the present-day landscape.

Boulder Batholith

South of Helena, the marine sediments were uplifted and shouldered to the side by a large (75 miles by 30 miles) molten granitic intrusion called the Boulder Batholith (see figure A-1). The batholith is actually a collection of at least 15 episodes of magmatic intrusions, spanning a 10-million-year period roughly 78 to 68 million years ago. Before the intrusion of the Boulder Batholith, volcanoes erupted, covering a large area of south-central Montana with thick lava flows and fine ash deposits collectively called the Elkhorn Volcanics (Smedes et al., 1973). The ash particles formed at depth where percolating ground water mixed with the molten magma (Sillitoe, 1984; Sillitoe and Bonham, 1984; and Sheridan and Wohletz, 1981). Volcanic gases and superheated steam carried the ash up and away from the volcanic vents similar in some ways to the recent Mount Saint Helens eruption.

The molten magma intrusion (Boulder Batholith) cooled, solidified, and fractured over the next 10 to 15 million years. Eventually, ground water began to circulate down into the batholith, leaching sulfide and precious metals down to a depth of 1/2 to 2 miles. These mineralized and heated waters then circulated back toward the surface along fractures and faults, forming much of the precious-metal mineralization found in and around the Boulder Batholith (Blackwell and Roberts, 1973).

Roughly 50 million years ago, the area underwent another cycle of volcanic ash deposition referred to as the Lowland Creek Volcanics. Upwelling mineralized hot water again invaded the fractured surrounding bedrock. The Montana Tunnels and other Corbin-Wickes district mineralized areas owe their origin to this second cycle of volcanic activity.


112° 30'
112° 00'
46° 30'
46° 00'
Helena
Garrison J.
Elliston
Clancy
Centennial
Minerals Project
Basin
Boulder
Warm
Springs
Butte
Whitehall
SCALE: 1" = 10 (±) miles
Post-batholith volcanic & sedimentary rocks of Cenozoic age
Pre-volcanic rocks
Includes strata of Mesozoic, Paleozoic, and
late Precambrian age, and metamorphic
rocks of early Precambrian age
Boulder batholith and associated plutons
Satellitic plutons
Elkhorn Mountains Volcanics of Late
Cretaceous age
Includes intrusive rocks correlated
with the volcanics
MONTANA

APPENDIX 2

ARM 16.20.618 B-1 Classification

(1) Waters classified B-1 are suitable for drinking, culinary and food processing purposes, after conventional treatment, bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers and agricultural and industrial water supply.

(2) For waters classified B-1 the following specific water quality standards shall not be violated by any person:

(a) During periods when the daily maximum water temperature is greater than 60°F, the geometric mean number of organisms in the fecal coliform group must not exceed 200 per 100 milliliters, nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliforms per 100 milliters.

(b) Dissolved oxygen concentration must not be reduced below 7.0 milligrams per liter.

(c) Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 must be less than 0.5 pH unit. Natural pH outside this range must be maintained without change. Natural pH above 7.0 must be maintained above 7.0.

(d) The maximum allowable increase above naturally occurring turbidity is 5 nephelometric turbidity units except as permitted in ARM 16.20.633.

(e) A 1°F maximum increase above naturally occurring water temperature is allowed within the range of 32°F to 66°F; within the naturally occurring range of 66°F to 66.5°F, no discharge is allowed which will cause the water temperature to exceed 67°F; and where the naturally occurring water temperature is 66.5°F or greater, the maximum allowable increase in water temperature if 0.5°F. A 2°F per hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55°F, and a 2°F maximum decrease below naturally occurring water temperature is allowed within the range of 55°F to 32°F. This applies to all waters in the state classified B-1 except for Prickly Peak Creek from McClellan Creek to the Montana Highway No. 433 crossing where a 2°F maximum increase above naturally occurring water temperature is allowed within the range of 32°F to 65°F; within the naturally occurring range of 65°F to 66.5°F, no discharge is allowed which will cause the water temperature to exceed 67°F; and where the naturally occurring water temperature is 66.5°F or greater, the maximum allowable increase in water temperature is 0.5°F.

(f) No increases are allowed above naturally occurring concentrations of sediment, settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.

(g) True color must not be increased more than five units above naturally occurring color.

(h) Concentrations of toxic or other deleterious substances which would remain in the water after conventional water treatment must not exceed the maximum contaminant levels set forth in the 1975 National Interim Primary Drinking Water Standards (40 CFR Part 141) or subsequent revisions or the 1979 National Secondary Drinking Water Standards (40 CFR Part 143) or subsequent revisions. The maximum allowable concentrations of toxic or deleterious substances also must not exceed acute or chronic problem levels as revealed by bioassay or other methods. The values listed in EPA Water Quality Criteria documents (Federal Register Vol. 45, No. 231, Friday, November 28, 1980, pages 79318-79379) shall be used as a guide to determine problem levels unless local conditions make these values inappropriate. In accordance with section 75-5-306(1), MCA, it is not necessary that wastes be treated to a purer condition than the natural condition of the receiving water.

(3) The board hereby adopts and incorporates by reference "EPA Water Quality Criteria documents (Federal Register Vol. 45, No. 231. Friday, November 28, 1980, pages 79318-79379)", which set forth water quality criteria for toxic or other deleterious substances. Copies of this document may be obtained from the Water Quality Bureau, Department of Health and Environmental Sciences, Cogswell Building, Capitol Station, Helena, Montana 19620. (History: Sec. 75-5-301 MCA; IMP, Sec. 75-5-301 MCA; Eff. 12/31/72; AMD, Eff. 11/4/73; AMD, Eff. 9/5/74; AMD, 1980 MAR p. 2252, Eff. 8/1/80; AMD, 1982 MAR p. 1746, Eff. 10/1/82; AMD, 1984 MAR p. 1802, Eff. 12/14/84.)

APPENDIX 3: Chemical Characteristics of Existing Mine Drainage in the Montana Tunnels Project Area

Station location and date	Flow (cfs)	pH	Conductivity (umphs)	Concentrations (mg/l)								
				Sulfate	Ag	As	Cd	Cu	Fe	Mn	Pb	Zn
Mine seep at base of Alta Mountain 06/07/77	1 GPM	6.0	818	445	<.01	.004	<.005	<.01	37	18	<.05	.72
Mine seep on Wood Chute Creek 06/07/77	.30	7.0	1145	675	<.01	5.1	.12	.23	17	13	1.6	24
Seep from Washington Mine 06/07/77	50 GPM	7.2	654	200	<.01	.18	.005	<.01	5.9	2.9	<.05	3.1
Water flowing through Gregory Mine	2 GPM	6.7	403	188	<.01	.34	.018	.32	18	.99	.10	1.9

Impact of Abandoned Mine Drainage on Streams in the Project Area

Station location and date	Flow (cfs)	pH	Conductivity (umphs)	Concentrations (mg/l)								
				Sulfate	Ag	As	Cd	Cu	Fe	Mn	Pb	Zn
Spring Creek above Corbin 06/07/77	3.27	7.8	388	137	<.01	.019	<.005	.01	.16	.03	<.05	.04
Spring Creek below Corbin 05/12/75	---	---	1050	---	---	.35	.238	14	71	53	2.2	60
06/09/77	2.51	7.0	476	153	<.01	.01	.013	.14	2.7	7.8	<.05	5.5
Clancy Creek above Kady Gulch 06/07/77	1.04	7.6	268	95	<.01	.003	<.005	<.01	.50	.48	<.05	.10
Clancy Creek at mouth 06/06/77	1.53	8.0	261	49	<.01	.011	<.005	<.01	.22	.03	<.05	.02

Source: Montana Department of Health and Environmental Sciences, 1977.

APPENDIX 4

Physical Characteristics and Toxicity of Mineral Processing Reagents

Sodium Cyanide: This reagent is used in the cyanide process for extracting gold and silver from the ore. Sodium cyanide is a simple alkali metal salt which dissociates in aqueous solution. Upon dissociation, the cyanide ion combines with a hydrogen ion to form hydrocyanic acid (HCN) (Dupont, no date). Although highly toxic to aquatic life, HCN occurs only rarely in nature due to the reactivity of the molecule. In the environment, cyanides are connected to other compounds, or they form complexes with trace metals. The stability of metallocyanides formed with cadmium are unstable, while those formed with cobalt and iron are very stable. The iron cyanides however, dissociate to release toxic cyanide ions in the presence of sunlight. Photochemical degradation of ferrocyanide and ferric cyanide is considered the major environmental concern regarding persistence of cyanide in the environment.

Almost all toxicological studies have been directed toward measuring the effect of free cyanides on aquatic organisms. Little information has been developed discussing the fate of cyanides, cyano complexes, and cyanates in the environment. The following inhalation toxicity data are estimated human responses to various concentrations of HCN (National Institute of Occupational Safety and Health, 1976):

330 ppm.....Rapidly fatal if no emergency aid is administered
100-200 ppm.....Fatal within 1/2 to 1 hour
45-54 ppm.....Tolerated for 1/2 to 1 hour without immediate or delayed effects
20-40 ppm.....Slight symptoms after several hours
10 ppm.....Threshold limit/time-weighted average for a normal 8-hour workday
2-5 ppm....Odor threshold

Cyanide ingested by humans at quantities of 10 milligrams or less per day is not toxic and is biotransformed to the less-toxic thiocyanate. Continuous long-term consumption of up to 5 milligrams per day has shown no injurious effects. Lethal toxic effects from the ingestion of water containing cyanide occur only when cyanide concentrations are high and overwhelm the detoxifying mechanisms of the human body (U.S. Environmental Protection Agency, 1976).

A review of available data on acute toxicity of simple cyanides to fish reveals the following minimum lethal concentrations:

brook trout -- 0.05 mg/l
rainbow trout -- 0.07 mg/l
brown trout -- 0.07 mg/l

The Environmental Protection Agency (EPA) has concluded that free cyanide concentrations in the range of 0.05 to 0.10 mg/l as cyanide have proven eventually fatal to many sensitive fishes. Levels above 0.20 mg/l are probably rapidly fatal to most fish species (U.S. Environmental Protection Agency, 1976).

Although HCN is the most toxic form of cyanide in water, the ratio of HCN to total cyanide is variable and depends on pH, temperature, soils, natural oxidants, bacteria, and photochemical actions. For these reasons, the EPA cyanide criteria of 0.0052 mg/l is based on the concentration of total cyanide.

A workshop sponsored by the National Science Foundation suggests that further research needs to be completed regarding the fate and toxicity of cyanide in the environment (National Science Foundation, 1983). However, there are no areas identified where the proper use and handling of cyanide in current operations has an adverse environmental impact.

Xanthate: This reagent is an alkylxanthate salt used as a collector in the bulk and lead/zinc flotation processes. It is poisonous when absorbed through the skin or swallowed. Xanthates are toxic to fish and aquatic life. They should be used in a closed-ventilation system and stored in cool, dry, well-ventilated areas.

Aero 208: Aero 208 is a phosphorodithioate salt used as a collector in the flotation process. It can cause burns to eyes or skin. Engineering controls are not needed to protect workers from exposure if good hygiene practices are strictly followed.

Copper Sulfate: Copper sulfate combines with sulfide particles and promotes flotation. This reagent is poisonous if swallowed. Copper sulfate dust is irritating to the nose and throat. It is harmful to aquatic life in very low concentrations.

MIBC and Dow 250: Both these reagents act as promoters in the flotation process by producing a froth. They are not considered to be highly toxic but can cause skin irritation, anesthesia if inhaled, and should not be ingested. Both reagents have a low toxicity to aquatic life.

Zinc Dust: This reagent precipitates gold and silver from the cyanide solution. Zinc dust is toxic if heated. Inhaling the dust should be avoided.

Lead Nitrate: Lead nitrate assists in the precipitation of the gold and silver from the cyanide solution. It is toxic if ingested.

Diatomaceous Earth: Diatomaceous earth is a friable earthy complex of nearly pure silica and diatoms which is added to the gold circuit and used for filtration. This reagent should not be inhaled.

Lime: Lime is used in mineral processing to control pH. Lime dust can cause drying of skin and eye irritation.

Sodium Silicate: Sodium silicate is used in lead sulfide flotation as a dispersant. It is not considered to be highly toxic but dust must be controlled and not inhaled.

APPENDIX 5

Common and Scientific Names of Plant Species

Common Name	Scientific Name
Grasses and grasslike	
Rough fescue	*Festuca scabrella*
Bluebunch wheatgrass	*Agropyron spicatum*
Idaho fescue	*Festuca idahoensis*
Prairie junegrass	*Koeleria cristata*
Needle-and-thread	*Stipa comata*
Kentucky bluegrass	*Poa pratensis*
Cheatgrass	*Bromus tectorum*
Elk sedge	*Carex geyeri*
Pinegrass	*Calamagrostis rubescens*
Slender wheatgrass	*Agropyron trachycaulum*
Wheatgrass	*Agropyron* spp.
Orchard grass	*Dactylis glomerata*
Oats	*Avena sativa*
Barley	*Hordeum* sp.
Timothy	*Phleum* sp.
Redtop	*Agrostis alba*
Wheat	*Triticum* sp.
Canada bluegrass	*Poa compressa*
Mountain brome	*Bromus marginatus*
Tufted hairgrass	*Deschampsia caespitosa*
Colonial bentgrass	*Agrostis tenuis*
Crested wheatgrass	*Agropyron desertorum* or *A. cristatum*
Forbs	
Silky lupine	*Lupinus sericeus*
Ballhead sandwort	*Arenaria congesta*
Tufted fleabane	*Erigeron caespitosus*
Common dandelion	*Taraxacum officinale*
Sulfur buckwheat	*Eriogonum umbellatum*
Hairy golden aster	*Heterotheca villosa*
Prairiesmoke	*Geum triflorum*
Missouri goldenrod	*Solidago missouriensis*
Rose pussytoes	*Antennaria microphylla*
Dalmation toadflax	*Linaria dalmatica*
Yarrow	*Achillea millefolium*
Arrowleaf balsamroot	*Balsamorhiza sagittata*
Woodland strawberry	*Fragaria vesca*
Littleleaf penstemon	*Penstemon procerus*
Marsh valeriana	*Valeriana dioica*
Showy aster	*Aster conspicuus*
Veiny meadowrue	*Thalictrum venulosum*
Mountain sweetroot	*Osmorhiza chilensis*
Northern bedstraw	*Galium boreale*
Iris	*Iris* sp.
Alfalfa	*Medicago sativa*
Clover	*Trifolium* sp.
Sticky geranium	*Geranium viscosissium*

Common Name	Scientific Name
Shrubs	
Big sagebrush	*Artemisia tridentata*
Green rabbitbrush	*Chrysothamnus vicidiflorus*
Wood's rose	*Rosa woodsii*
Antelope bitterbrush	*Purshia tridentata*
Oregon grape	*Mahonia repens*
Common snowberry	*Symphoricarpos albus*
Red raspberry	*Rubus idaeus*
Serviceberry	*Amelanchier alnifolia*
White spirea	*Spirea betulifolia*
Currant	*Ribes* spp.
Maple	*Acer glabrum*
Trees	
Dougla-fir	*Pseudotsuga menziesii*
Ponderosa pine	*Pinus ponderosa*
Lodgepole pine	*Pinus contorta*
Quaking aspen	*Populus tremuloides*

APPENDIX 6

Common and Scientific Names of Wildlife Species

Common Name	Scientific Name
Mammals	
Elk	*Cervus elaphus*
Mule deer	*Odocoileus hemionus*
Black bear	*Ursus americanus*
Coyote	*Canis latrans*
Moose	*Alces alces*
Beaver	*Castor canadensis*
Snowshoe hare	*Lepus americanus*
Columbian ground squirrel	*Spermophilus columbianus*
Porcupine	*Erethizon dorsatum*
Long-tailed weasel	*Mustela frenata*
Red squirrel	*Tamiasciurus hudsonicus*
Golden-mantled ground squirrel	*Spermophilus lateralis*
Deer mouse	*Peromyscus maniculatus*
Caribou	*Rangifer tarandus*
White-tailed deer	*Odocoileus virginianus*
Birds	
Red-tailed hawk	*Buteo jamaicensis*
Rough-legged hawk	*Buteo lagopus*
Golden eagle	*Aquila chrysaetos*
Bald eagle	*Haliaeetus leucocephalus*
Goshawk	*Accipiter gentilis*
Cooper's hawk	*Accipiter cooperii*
American kestrel	*Falco sparverius*
Screech owl	*Otus asio*
Saw-whet owl	*Aegolius acadicus*
Pygmy owl	*Glaucidium gnoma*
Mountain chickadee	*Parus gambeli*
Dark-eyed junco	*Junco hyemalis*
Red-breasted nuthatch	*Sitta candensis*
Ruby-crowned kinglet	*Regulus calendula*
Robin	*Turdus migratorius*
Horned lark	*Eremophila alpestris*
Vesper sparrow	*Pooecetes gramineus*
Lark sparrow	*Chondestes grammacus*
Blue grouse	*Dendragapus obscurus*
Ruffed grouse	*Bonasa umbellus*
Fish	
Brook trout	*Salvelinus fontinalus*
Rainbow trout	*Salmo gairdneri*
Cutthroat trout	*Salmo clarki*
Brown trout	*Salmo trutta*
Mottled sculpin	*Cottus bairdi*

APPENDIX 7

Table 7A: Jefferson County Mill Levies by Fund and Percent of Total Levy

Fiscal year	General fund	Percent of total	Road and bridge funds	Percent of total	Poor fund	Percent of total	Total levy
1970	19.92	59.8	5.36	16.1	5.72	17.2	33.30
1975	23.49	66.9	7.10	20.2	3.63	10.3	35.12
1980	19.70	46.0	6.90	16.1	5.10	11.9	42.86
1981	19.94	46.2	4.13	9.6	7.00	16.2	43.15
1982	27.00	35.4	25.00	32.7	12.36	16.2	76.37
1983	21.78	37.7	20.20	34.5	6.80	11.8	57.78
1984	24.00	50.1	8.29	17.3	4.00	8.3	47.94
1985	27.00	42.2	19.00	29.7	6.00	9.4	63.95

Source: Montana Tax Foundation, annual.

Table 7B: Jefferson County Budget by Major Fund in 1980 Dollars

Fiscal year	General fund	Percent of total	Road and bridge funds	Percent of total	Poor fund	Percent of total	Total all funds
1980	$460,837	24.0	$469,959	24.5	$ 87,254	4.5	$1,226,952
1981	533,146	30.2	454,610	25.7	84,119	4.8	1,768,210
1982	719,891	39.3	618,786	33.8	104,363	5.7	1,829,803
1983	809,156	46.8	472,350	27.3	88,698	5.1	1,727,835
1984	887,308	44.9	503,102	25.4	90,429	4.6	1,978,225
1985	962,060	48.1	512,932	25.6	95,200	4.8	1,999,945
Percent change FY80 to FY85	108.8		9.1		9.1		63.0

Source: Jefferson County in Mountain International, Inc., 1984, p. 225.

Table 7C: Town of Boulder Expenditure and Revenue Components, FY81 to FY84 (1980 dollars)

Item	FY81	FY82	FY83	FY84	Percentage change FY81 to FY84
Expenditures					
General government	$35,400	$42,164	$37,514	$43,131	21.84
Public safety	65,615	69,667	67,105	63,198	-3.68
Public services	12,288	10,457	8,313	7,747	-36.96
Transportation	22,589	185,234	25,008	43,465	92.42
Education and culture	28,260	24,201	23,488	24,697	-12.61
Capital outlays/debt service	24,255	27,559	10,852	34,565	42.51
Total budget	188,407	196,361	172,280	216,803	15.07
Total operating budget	135,892	144,601	137,940	157,541	15.93
Revenues					
Property taxes	73,053	77,906	62,661	65,273	-10.65
Fees, fines, and licenses	23,155	26,125	26,035	20,675	-10.71
Intergovernmental transfers	68,002	62,300	59,398	79,643	17.12
Miscellaneous	24,065	19,256	24,305	46,352	92.61
Total revenue	188,321	185,587	172,399	211,944	12.54
Total local revenue	120,319	123,287	113,001	132,301	9.96

Source: Jefferson County in Mountain International, Inc., 1984, p. 228.

Table 7D: Taxable Value of Selected Jefferson County School Districts (1980 dollars)

Fiscal year	Clancy elementary district #1	Boulder elementary district #7	Montana City elementary district #27	Jefferson high school district #1
1980	$1,846,797	1,738,767	$2,658,603	$6,601,686
1981	1,863,861	1,581,594	2,440,664	6,120,335
1982	1,886,124	1,972,687	2,563,760	6,686,230
1983	1,637,513	1,674,425	2,470,859	5,965,626
1984	1,507,026	1,439,464	2,441,242	5,555,823
1985	1,786,370	2,830,872	2,462,170	8,367,552
Percentage change	-3.3	62.8	-7.4	26.7

Source: Jefferson County School Districts in Mountain International, Inc., 1984, p. 241.

Table 7E: Lewis and Clark County Mill Levies by Fund and Percent of Total Funds

Fiscal year	General fund	Percentage of total levy	Road and bridge funds	Percentage of total levy	Poor fund	Percentage of total levy	Total all funds
1970	18.00	40.99	10.35	23.57	9.18	20.91	43.91
1975	22.81	41.59	10.67	19.45	10.51	19.16	54.85
1979	15.40	25.88	15.00	25.21	7.72	12.97	59.51
1980	17.19	26.09	15.55	23.60	6.40	9.71	65.89
1981	20.73	29.79	15.38	22.10	7.89	11.34	69.58
1982	22.56	32.28	16.41	23.48	5.14	7.35	69.89
1983	25.00	25.15	18.71	18.82	13.50	13.58	99.42
1984	22.35	22.84	18.71	19.12	6.19	6.33	97.86
1985	19.51	20.50	18.34	19.27	3.57	3.75	95.17

Source: Montana Tax Foundation and Lewis and Clark County *in* Mountain International, Inc., 1984, p. 255.

Table 7F: Budget by Major Fund, Lewis and Clark County, FY79 and FY85 (1980 dollars)

Fiscal year	General fund	Percentage of total	Road and bridge funds	Percentage of total	Poor fund	Percentage of total	Total all funds
1979	$2,482,664	30.53	$1,241,845	15.27	$1,465,004	18.01	$8,132,484
1980	2,002,848	28.64	981,785	14.03	1,274,132	18.22	6,992,401
1981	2,197,494	32.46	893,785	13.20	1,288,726	19.03	6,770,562
1982	2,203,750	29.02	850,110	11.19	1,239,803	16.33	6,594,111
1983	2,080,111	30.49	669,426	9.81	768,691	11.27	6,823,321
1984	2,325,003	32.08	804,916	11.11	557,545	7.69	7,248,157
1985	2,437,427	29.08	795,032	9.48	906,202	10.81	8,382,648
Percentage change	-1.8		-36.0		-38.1		3.1

Source: Lewis and Clark County *in* Mountain International, Inc., 1984, p. 254.

Table 7G: Mill Levies

Fiscal year	State levy	Percent	County levy	Percent	City levy	Percent	County-wide general school	Percent	Total
1980	6.00	2.5	53.89	22.7	66.32	27.9	69.91	29.4	237.68
1981	5.65	2.2	57.58	22.9	71.5	28.4	66.19	26.3	251.33
1982	N/A		N/A		N/A		N/A	N/A	N/A
1983	6.00	2.33	84.40	32.8	83.5	32.5	83.3	32.4	257.21
1984	5.86	1.9	82.86	26.6	76.87	24.6	85.98	27.6	312.05
1985	6.00	1.9	80.18	25.5	75.12	23.9	86.28	27.5	314.14

Table 7H: Taxable Value of Selected Lewis and Clark County School Districts, FY80 to FY84 (1980 dollars)

Fiscal year	Helena elementary district #1	Kessler elementary district #2	Warren-Darcy elementary district #3	East Helena elementary district #9	Helena high school district #1
1980	$34,486,019	$2,664,168	$4,850,173	$6,958,863	$53,104,534
1981	32,679,564	2,475,269	4,845,504	6,775,608	50,646,798
1982	30,401,478	2,181,609	4,431,907	6,574,751	47,232,793
1983	26,621,248	1,835,591	3,880,188	5,762,092	41,453,709
1984	26,830,860	1,933,880	4,122,938	5,923,322	41,883,916
1985	28,296,038	2,099,249	4,536,946	6,227,484	44,850,179
Percentage change	-17.95	-21.20	-6.46	-10.51	-15.54

Source: Montana Office of Public Instruction and Lewis and Clark County School Districts in Mountain International, Inc., 1984, p. 265.

Table 71: City of Helena Expenditure and Revenue Components, FY81 to FY84 (1980 dollars)

Fiscal item	FY81	FY82	FY83	FY84	Percentage of total FY84 budget	Percentage change FY81 to FY84
Expenditures						
General government	$872,124	$863,549	$868,480	$940,299	21.2	7.82
Public safety	1,404,616	1,472,798	1,529,542	1,688,164	34.5	20.19
Public services	777,712	700,297	585,925	573,239	11.7	-26.29
Transportation	799,556	624,256	764,173	1,197,699	24.5	49.80
Capital outlays/debt service	160,007	193,108	246,009	454,550	9.3	184.08
Miscellaneous	61,685	51,571	40,452	34,789	0.7	-43.60
Total budget	4,075,699	3,905,580	4,075,033	4,888,739	100.0	19.95
Total operating budget	3,915,693	3,712,472	3,829,024	4,434,189	90.7	13.24
Revenues						
Property taxes	1,930,511	1,982,361	1,985,741	1,880,539	38.5	-2.59
Fees, fines, and licenses	1,185,680	1,069,344	907,786	1,041,352	21.3	-12.17
Intergovernmental transfers	672,747	760,662	678,368	834,894	17.1	24.10
Miscellaneous	287,296	228,952	578,363	1,150,479	23.5	300.45
Total revenue	4,076,233	4,041,319	4,150,274	4,907,264	100.4	20.39
Total local revenue	3,403,486	3,280,657	3,471,906	4,072,370	83.3	19.65

Source: City of Helena Budget, annual, in Mountain International, Inc., 1984, p. 260.

Chapter VII:

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Chapter VIII:

Consultation and Coordination

The following people prepared the EIS:

Carole Armstrong, Office Manager

Dan Ashenberg, Hydrologist
- B.S. Biology, Tulane University, 1975
- M.S. Water Resources Management, University of Wisconsin, 1982

Pat Driscoll, Air Quality Specialist
- B.S. Environmental Engineering, Montana College of Mineral Science and Technology, 1978.

Jim Dushin, Graphic Artist
- B.S. Wildlife Biology, University of Montana, 1985

John Herrin, Geologist
- B.S. Earth Science, California State University, Long Beach, 1974
- B.S. Geology, Northern Arizona University, 1975

Scott McCollough, Wildlife Biologist
- B.S. Wildlife Biology, Colorado State University, 1977
- M.S. Wildlife Biology, Colorado State University, 1982

A. Sharleen Pendergrass, Editor
- B.A. English, University of Montana, 1984

Scott Spano, Soil Scientist
- B.S. Forestry, Michigan Technological University, 1976
- M.S. Forest Soils, Michigan Technological University, 1978

Lois Steinbeck, Economist
- B.S. Economics, Colorado State University, 1977

Kit Walther, Project Chief
- B.S. Zoology, University of Montana, 1966
- M.S.T. Biological Sciences, University of Montana, 1971

REVIEW

The following people from the Department of State Lands reviewed this document:

Gary Amestoy, Reclamation Division Administrator
Chuck Baltzer, Geologist
Ed Gensler, Geologist
Terry Grotbo, Hard Rock Bureau Chief
Matt Lewis, Reclamation Specialist
Gary Lynch, Range Scientist
John North, Legal Counsel
P. Dennis Smith, Hydrologist

PEOPLE, AGENCIES, AND COMPANIES CONSULTED

The following people and companies (other than those cited in the text) provided information used to analyze the Montana Tunnels project:

Montana State Board of Education, Helena (State Historic Preservation Program)
Montana Department of Administration, Research and Statistical Services (Helena)
Montana Department of Commerce, Economic and Community Development Division (Helena)
Montana Department of Commerce, Hard Rock Mining Assistance Board (Helena)
Montana Department of Fish, Wildlife and Parks (Helena)
Montana Department of Health and Environmental Sciences, Air Quality Bureau and Water Quality Bureau (Helena)
Montana Department of Justice, Highway Traffic Safety Section (Helena)
Montana Department of Highways, Planning and Research Bureau (Helena)
Montana Power Company

REVIEW OF THIS STATEMENT

In accordance with environmental law, copies of the draft EIS have been sent to the public for comments and suggestions. All comments will be carefully considered by the agencies. Address comments on the draft EIS to Commissioner Dennis Hemmer, Montana Department of State Lands, Capitol Station, Helena, Montana 59620.

The draft EIS is available for review in the following places:

Boulder Community Library, 201 S. Main, Boulder, Montana
Butte Public Library, West Broadway, Butte, Montana
John Gregory Memorial Library, 2 N. Whitehall, Whitehall, Montana
Lewis and Clark Library, 120 S. Last Chance Gulch, Helena, Montana
Montana College of Mineral Science and Technology, West Park Street, Butte, Montana
Montana Department of State Lands, 1625 11th Avenue, Helena, Montana
Montana State Library, 1515 E. 6th Avenue, Helena, Montana